finishing

PLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING,
ING, METAL SPRAYING and all METAL FINISHING PROCESSES

Vol. 4 No. 42 (New Series) JUNE, 1958

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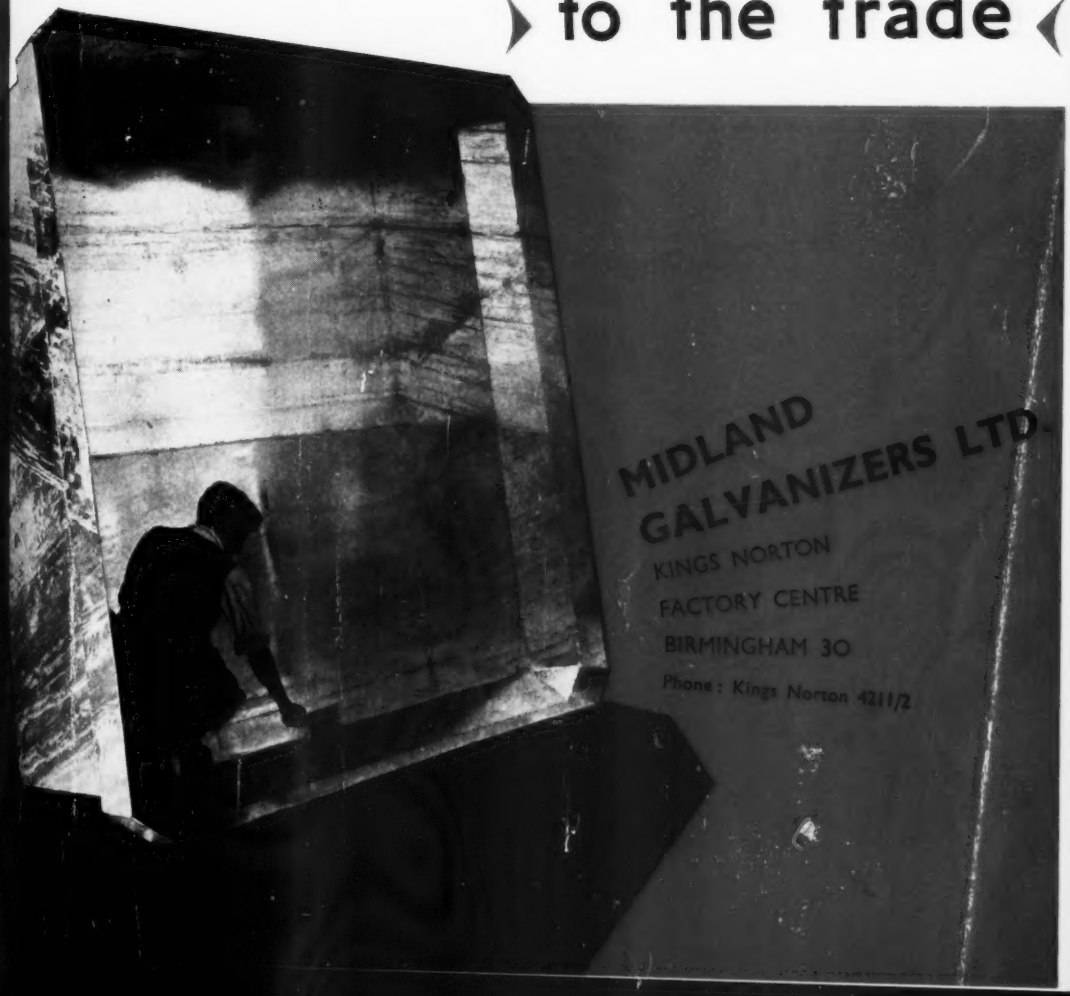

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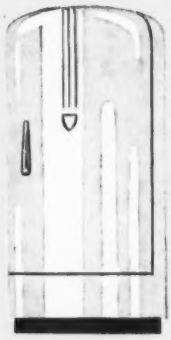

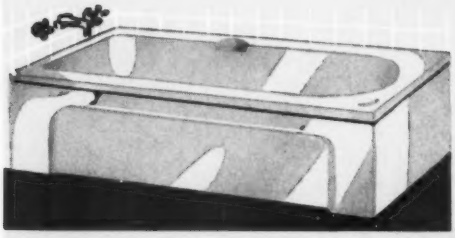

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June, 1958 Vol. 4, No. 42 (New Series)

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17-19 JOHN ADAM STREET
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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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GIANT

OVER thirty pages of this issue of "Metal Finishing Journal" are devoted to a detailed and comprehensive description of the new finishing plant and facilities installed at the Luton Works of Vauxhall Motors Ltd. as part of that company's £36 million expansion scheme. The processes dealt with in the course of this description include cleaning, phosphating, painting, polishing and electroplating, together with such ancillary subjects as effluent disposal and fire precautions.

The publication of this description is of significance from several points of view. It is, in the first place, a description of capital investment on a very large scale in the most modern finishing plant available, and expenditure of this order is certainly worthy of note.

The fact that much of the installation comprises plant for the deposition of bright nickel followed by chromium on car body trim, must be taken as an indication that the company is satisfied with the performance of nickel chromium plate in such applications and does not envisage any swing away from these materials, either for economic or technological reasons, or in response to a change in popular demand.

Furthermore, the installation of this very great range of finishing equipment has highlighted the position of the motor car as probably the most important single user of industrial finishes. The considerable part played by the motor car industry in earning foreign currency through its exports has made that industry assume such economic significance that it is in many respects responsible for the existence and survival of many other suppliers of materials and processes. This is very much so in the case of the metal finishing industry, which is tending to look more and more to the finishing departments of the manufacturers of motor cars and motor car components as the primary source of technological progress and development in the use and application of metal finishes.

The existence however, of a mammoth customer whose demands preponderate over those of lesser consumers, while it may have advantages from certain points of view, cannot be regarded as a wholly unmixed blessing. The investment of very large capital sums in plant and equipment for the carrying out of a given finishing process must bulk very largely in the minds of those who might be considering the adoption of some alternative finish or material with consequent influence on their freedom of choice.

Such lack of flexibility of approach in the choice of a finishing system must react unfavourably on the development of new processes unless it can be shown that the economic advantages of the new process markedly outweigh the cost of amortizing existing plant.

Another disadvantage, albeit a commercial rather than a technical one, stems from the dangers of having too many eggs in a single basket, whereby a falling off for any reason whatsoever in one particular industry can have disproportionate repercussions on the activities of those whose fortunes are too closly bound up with it.

Nevertheless, having paid due regard to the dangers attendant upon the situation it must be said that up to the present time a very great deal of progress and development in the metal finishing field has been directly inspired by the needs of the motor car industry which has always shown itself very much alive to the necessity for a proper appreciation of metal finishing.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

HOT BEADS

A NOVEL method of drying has been developed by the British Rayon Research Association which may find wider applications than the textile industry. It consists essentially of blowing hot air through a bed of tiny glass beads, known as ballotini, similar to those used in making reflector paints. The glass bead mass becomes "fluidised" and provides a very efficient means of transferring heat to fabrics for drying, dyeing, or for baking on synthetic resins employed in making crease-resisting and "drip-dry" materials.

It has been found, for instance, that fabrics can be dried four or five times more quickly than by any other method, whilst a high degree of uniformity of temperature is obtained. Synthetic resins are stoved in one pass in 20 seconds as compared with two operations lasting 4 minutes. The theory behind the method is that heat is transferred by solid to solid contact from the ballotini to the fabric; the rapid movement of the glass beads leads to speedy heat transfer because of the breakdown of the static air layer which slows the rate of heat transfer from gases to solids.

The characteristics of the process indicate that it might be useful for drying racked articles on automatic plating plants where time available for complete drying is often short. The burnishing action of the beads might even serve to brighten the finish in the case of zinc or cadmium, for instance, although a possible objection may arise in the case of complex shaped articles where the beads might be cupped out and removed from the unit.

SWEATING IT OUT

"HORSES sweat, men perspire, but ladies are all aglow." So runs the dictum in the Book of Etiquette, but whatever one may call the stuff, the fact remains that perspiration causes a great deal of trouble by initiating corrosion when metal components are handled. Steel is particularly sensitive, as are also cadmium and zinc plated articles of all kinds. Sometimes finger marks on a steel surface will show themselves through cadmium plate in the form of corrosion patterns months later.

It is also well known that certain individuals are more prone to corrode sensitive metals when handling them than others, and it is with interest therefore that we see that a German instrument has been developed which will detect the relative proneness of different people towards hand perspiration. It is a self-contained unit consisting of a hand-grip and a current measuring device. By gripping the handle a pointer on the dial shows the relative conductivity of the skin surface which depends on the amount of saline present. It is claimed that in this way workers who are most likely to cause corrosion troubles when they handle metals can be sorted out with a high degree of reliability.

A number of interesting observations have been made as a result of the use of this instrument. Astringent hand creams are very useful in preventing attack, whilst it is important that the hands should be thoroughly rinsed free from soap and dried after washing, as soap residues can cause corrosion. One curious fact is that the hands seem to perspire more on Mondays than on other week days!

S.C.I. — ence.

THE Society of Chemical Industry has a number of excellent specialized groups, notably the Corrosion Group, which during the short time it has been in existence has become one of the more important bodies in the metal-finishing field. The services which the Groups give to industry are valuable and practical; the activities of the main Society, on the other hand, appear to me, as a member of some years' standing, to be somewhat woolly and often totally inappropriate in a body whose object is ostensibly to promote the interests of the chemical industry.

This year's meeting is to be held in Exeter in July; it will last a full week and during that time will hear only five papers, all presented by professors and having little apparent bearing on the subject of the chemical industry, its problems and achievements. One paper (believe it or not) is entitled "The Cow and the Inquisitive Chemist" and another is on "Science and English Literature."

How is the rest of the time to be filled in? By visits to factories and installations covering such a wide diversity of industries that most of them can only be of little direct interest to any individual member of the Society. There will also be the usual quota of receptions, dinners and luncheons.

The S.C.I. is a body of considerable standing, but as an industrialist I find myself wondering whether its annual meeting is really necessary, and if it is, whether it should continue to be held on this scale and in this form.

FINISHING THE VAUXHALL CAR

A Comprehensive Description of the NEW PLANT AND FACILITIES

Installed at the Luton Works of VAUXHALL MOTORS Ltd.

THE facilities for electroplating, polishing and painting now in operation at the Luton works of Vauxhall Motors Ltd., form a part of the recently completed overall £36-million expansion scheme designed to allow the company to produce 250,000 cars, vans and trucks each year.

The main feature of the scheme is the construction of a new 1½-million sq. ft. building (Block AC) which incorporates the modern press shop, body building, trim, final assembly and paint shops.

Other features of the scheme include the re-equipment of the mechanical components building (Block AA) and the addition of extensive electroplating and polishing equipment, all of which is housed in one building (K Block).

Wherever possible automatic production and handling equipment has been installed, so that by means of conveyors linking the various production units in one building, and also linking one building with another, continuous "flow" production in the true sense has been achieved.

Components produced in the press shop, for example, on mechanized press lines which incorporate multi-spot and press-welder equipment, flow to the body assembly and sub-assembly tracks, through the paint and trim shops and to the final assembly conveyor where components from AA block are brought by conveyor through linking bridges.

Metal finishing operations commence on the body finishing conveyor in AC block which carries the body shell prior to painting. This conveyor pulls a large number of light-weight trucks along through the body finishing stations. The first series of operations is concerned with the dressing and preparation of welded joints, a process which includes solder loading. When this has been completed the body shells on their trucks pass into the sanding booths, which are well-lit tunnel structures equipped with hydrostatic dust extraction and air-replacement plant which includes filtration equipment, giving a large number of six changes

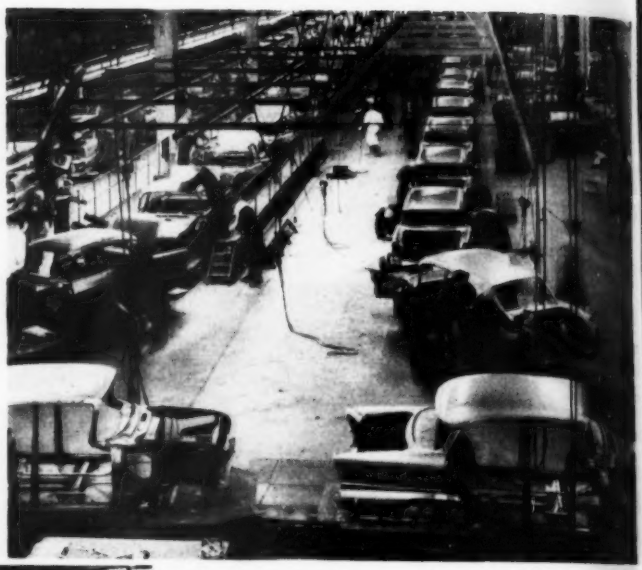


Fig. 1.—(right) General view of the body-in-white finishing line on which such operations as solder loading and dressing of welded joints are carried prior to Bonderizing and painting.

Fig. 2.—(below) Weld dressing and sheet-metal finishing on body finishing line.

per hour. The whole installation was manufactured by Spencer and Halstead Ltd. (Fig. 3).

After sanding, the body shell is fitted with doors and trunk lid. This completes the " body-in-white " as far as construction is concerned.

The subsequent operations are all devoted to treatment of the surface of the body prior to painting, and the adjustment of hinges to give proper door and trunk-lid fitting, making due allowance for the weather-strips and draught-excluding arrangements which follow after painting.

Inspections of surface finish and rectification of skin-panel surfaces are the final operations undertaken before the body shell is lifted from the body truck and transferred on to the phosphate overhead storage conveyor, which employs special slings for carrying the complete body shell. The transfer from floor conveyor to overhead conveyor is accomplished without interrupting the flow of work.

THE PAINT SHOP

Occupying part of the first floor of the new car manufacturing building at Luton, and separated from the trim shop by a fire-wall, the paint shop covers an area of 91,125 sq. ft. Above the paint shop is a penthouse of 83,531 sq. ft. floor area in which are installed drying and stoving ovens, air-replacement and ventilation plant serving the paint shop.

As the volume of production is planned at such a high level (40 bodies and associated sheet-metal parts per hour) the quantities of cellulose paint, thinners, solvents, and other highly volatile liquids to be stored constitute a considerable fire risk. To obviate this, a separate building, the paint storage, mixing and distribution house (floor area 5,470 sq. ft.) has been built to serve all areas within the main building. Paint is pumped to all points of application *via* distribution piping.

The paint shop divides itself into two principal sections. One deals with the body shell, and the other section with those sheet metal panels and small components which are assembled to the vehicle

Fig. 3.—Interior view of solder-sanding booth installed by Spencer and Halstead Ltd.

at later stages. In addition, there are a number of painting operations classified as finishing operations which are carried out after the vehicle has been completely built. This series of operations is carried out on the ground floor, in the assembly hall.

Conveyor Systems in the Body Painting Section

The paint shop is served by a system of synchronized conveyors which carry the body shell complete (less front wings and bonnet and other small fittings) through the entire painting system in a continuous flow.

The first body-shell conveyor is the body phosphate and storage and transport conveyor. This one is 2,183 ft. in length. It includes a storage run to which bodies are fed to be held as a bank for one hour. This arrangement ensures that no body shell is left in the phosphate plant during the lunch hour.

The continuation run carries the body through

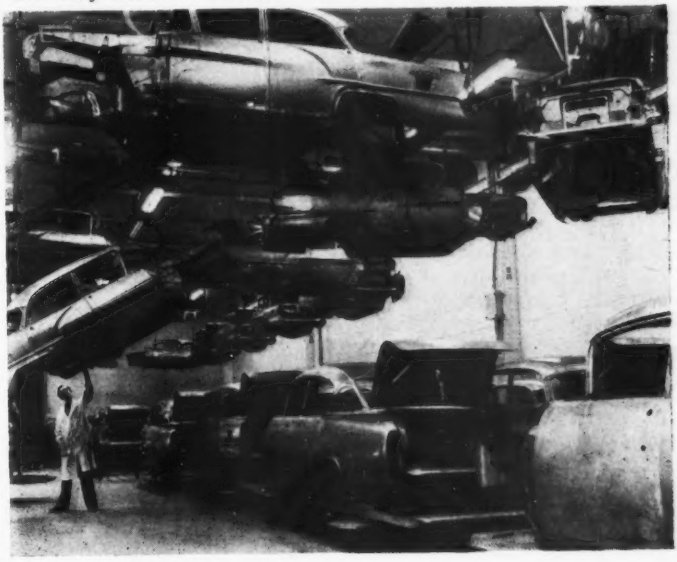


Fig. 4.—Storage conveyor for body Bonderizing plant. On this conveyor, bodies are held as a bank for one hour (the lunch-time break). This arrangement ensures that no body shell is left in the phosphate plant during the above period.

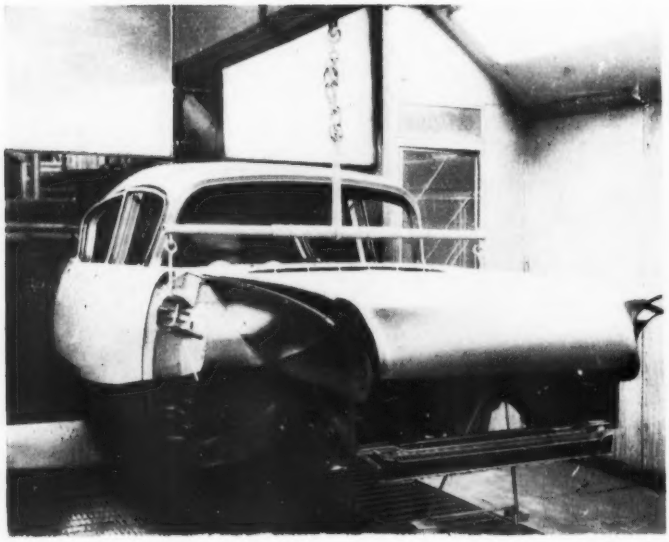


Fig. 5.—Underbody dipping following Bonderizing and upper body sealing.

the automatic phosphate plant, to a dry-off oven. The body is transferred to the next conveyor without interrupting the flow of work or stopping the conveyors. This is achieved by means of a special manually operated air-hoist. The second conveyor is 3,060 ft. in length, and carries the body through the underbody dip, primer surfacer spray booth, primer drying oven in the penthouse, and then back to the paint shop for underbody sealing.

From this point the body is carried to the wet sanding deck, and up once more to the next drying oven in the penthouse. Descending from the penthouse, the body moves on to the colour-coat spraying booths. After colour spraying the conveyor takes the body once more up to the colour drying oven in the penthouse. From this point it descends again to the paint shop, where it is transferred either to the polish conveyor which runs at floor level, or to a separate colour booth and oven for Duotone painting.

The total length of these three conveyors is approximately 7,139 ft. (approximately 1¾ miles).

A central control desk enables the controller to set conveyor speeds to give the scheduled output of painted bodies in terms of bodies per hour. In addition, the control panel provides immediate information of the location and cause of stoppage of the conveyors. These include the safety devices incorporated in the conveyors such as tension switches, drive failures, emergency stop buttons and body overrun.

BODY PAINTING IN DETAIL

Phosphating

The prepaint operations include cleaning—by hand—followed by the special rust-proofing processes (Spra-Bonderizing), which also serves as a key for the coats of paint. This equipment was installed by John Lysaghts Bristol Works Ltd., of Bristol, and was designed by the Newcomb-Detroit Company, U.S.A.

On entering the phosphating plant, after cleaning, the body receives a hot rinse with an alkali solution at 150 to 180° F. This is immediately followed by two hot-water rinses. The body then enters the Spra-Bonderizing section and is treated with high-pressure sprays after a cold-water rinse. Chromic-acid solution is also sprayed on to complete the Bonderizing process. The phosphating operations are completed by draining off, followed by drying-off in an oven.

The Bonderizing tunnel, a large sheet-metal structure, encloses independent spray sections and drain sections. The tunnel is elevated to the maximum height of the building clearance, thereby providing ease of maintenance for the tanks located directly underneath each stage.

The solutions are heated to the design temperature and delivered to the spray nozzles by a pumping system, the delivery rate at each nozzle being about 3.7 gal. per min., except at the Bonderite zone where the delivery rate is 4.3 gal. per min.

The desludging of the phosphate tank, which has a sloping bottom to ensure a minimum angle of repose of sludge, is effected by pumping from the bottom of the tank to a settling tank of a filter, and the desludged solution then returns to the main tanks by gravity flow.

The Newcomb-Detroit phosphate dry-off oven is of the tunnel type, elevated from the floor to give a head room of 8 ft. in which the heating plants are placed. The oven has a silhouetted air seal

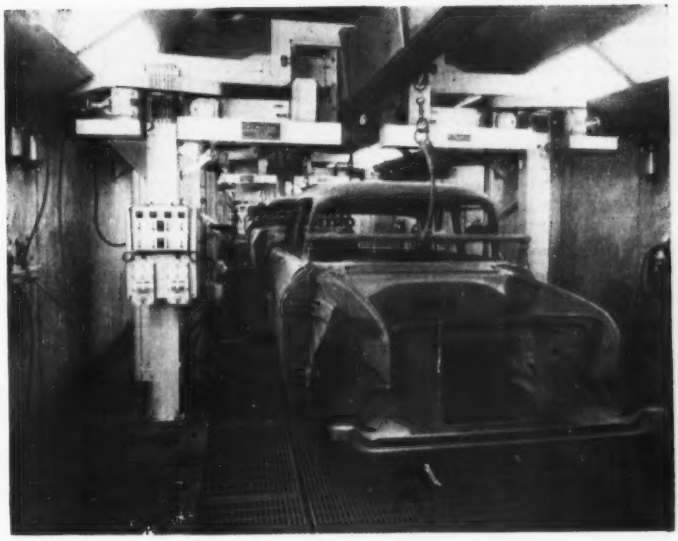


Fig. 6.—Carrier-Schweitzer automatic body painting machines; exit end of primer booth.

lock at the entrance end and a natural air seal at the exit end. The heating plant consists of steam-heated coils designed for forced-air circulation and positive exhaust and provides a 15 min. end-to-end drying zone at 320° F. The oven side walls, roof and floor are constructed of insulated inter-locking sheet-metal panels of the tongue-and-groove type, and are 4 in. thick by 2 ft. wide, supported by structural steel framing. The supply, recirculation and exhaust network is located inside the oven at head-room elevation. The supply duct has adjustable high-velocity nozzles and the recirculation duct is fitted with slide dampers.

All fans are of the centrifugal type, single width, single inlet, with backward curved blades, and with non-overloading characteristics. A forced-air cooler is provided at the end of the oven for cooling the body for 3 min. before transfer to the underbody dip conveyor.

Sealing

After emerging from the phosphate drying oven, the body is transferred to the paint conveyor. A special hoist enables this operation to be carried out without stopping the conveyors. The body,

Fig. 7.—Interior of primer surfacer bake oven.

at this station, is sealed at all required points above the dip line. A thermoplastic sealer is used, and is applied by means of pressure guns. The sealer sets hard in the stoving ovens which follow the underbody dip and primer surfacer operations.

Underbody Dip

The underbody dip is a process which applies a coat of special synthetic paint all over the inside and underside of the floor of the body. The paint also passes through holes provided for the purpose into the box sections of the body structure.

The conveyor speed of this plant is 12 ft. per min., and in addition to the 2,000-gal. main dip tank with overflow weir and ancillary equipment, there is an enclosed drain tunnel. The length of the drain section is based on a through time of 10 minutes, in which the bodies, dipped to a minimum depth of 12 in., tip down once and up twice. The whole of the drain section is enclosed with sheet steel and glass partitions. The plant incorporates an underground dump tank and automatic filtering and circulating pumps. Both the dip tanks and the underground tank are interlocked with a series of valves to effect the following operations :—

(i) Dump the contents of the dip tank in case of fire ;
(ii) Recirculate paint during shut-down periods;
(iii) Circulate paint during normal operations ;
(iv) Circulate paint to give additional filtration.

At all fire hazard points a fusible link is provided, automatically to cut out all electrical power supplied to pump fans, etc. A carbon-dioxide fire extinguisher system is also provided.

The special plant blends perfectly with the red oxide primer surface coats which are applied shortly after the dip operation. This process is designed to give additional protection against rust attack.

Primer Surfacer

The red oxide primer surfacer is applied in a Carrier Engineering double-sided spray booth 120 ft. long by approx. 16 ft. wide. The booth is of the water-washed exhaust type and is built on top of a water tank. Water is conducted through screen filters to the pumping equipment located at a platform below the paint-shop floor. These pumps recirculate the water to the exhaust chambers on each side of the booth. The booth floor is constructed of chequer plating with open-work floor grilles so that all overspray paint is drawn down into the water tank by the exhaust system. Filtered and tempered replacement air is introduced into the booth through a specially designed system featuring vertically mounted cloth-type distribution filters at high level, running the full length of the booth. Access is provided for filter maintenance.

The exhaust stacks are taken from the booth through the penthouse above to atmosphere, having the axial-flow fans located at penthouse level for easy maintenance.

Shadowless lighting is obtained by means of banks of fluorescent tubes located behind wired-glass panels. Paint distribution piping to the spray booth is built into a separate enclosure running the length of the booth on each side, and removable panels are provided for maintenance access.

Automatic Spraying

Two Carrier-Schweitzer automatic painting machines are installed to ensure adequate film

Fig. 8.—Carrier-Schweitzer automatic spraying equipment in the body shop.

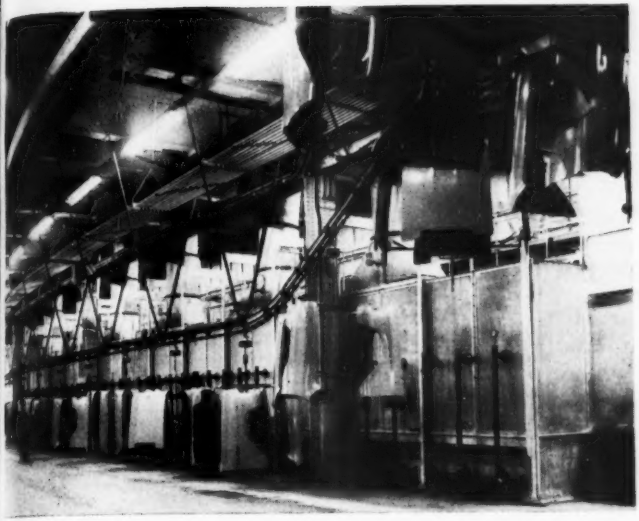


Fig. 9.—General view of the large sheet-metal components painting equipment.

thickness at maximum production. So far, however, only one machine has been found necessary.

Each painting machine consists of two side and two top units, one of each being arranged on either side of the conveyor and connected to a main control panel outside the spray booth. Each of the units is complete in itself and as all the services are prefabricated, the installation of a machine is very simple. Each unit carries a spray gun which reciprocates and follows the contours of the bodies such that the angle of spray, distance, and the speed of application are automatically adjusted during the operation to apply an even film of paint over the whole of the surface to be sprayed.

The machines are controlled by three sets of infra-red beams. As the body approaches it first cuts the control beam for the two side units, which causes the gun arm of these units to reciprocate, the paint to be turned on—and, at the end of the body run—the paint to be turned off. The side guns paint from the underside of the body to the waist-line, *i.e.*, the front and rear wings and the door panels.

The second control beam causes the two top units to reciprocate and paint in a similar manner to the side units.

A third control beam raises the top guns from the lower spraying position, to spray the roof, and lowers the guns again over the boot lid.

The machines are fitted with cut-off controls so that the start and finish of each stroke of the gun can be set to within an inch of the edge of the surface being painted. This accurate control not only conserves paint but prevents overspray and dried spray being formed.

The machines are designed to apply an even film thickness over constantly changing contours and yet they are so versatile that special requirements can easily be met if necessary. For instance, after the body in the white has been slipper-dipped it is necessary for the automatically sprayed primer coat to have its thickness reduced when passing over the dipped area to avoid a ridge line, and this requirement is easily met.

The machines are interlocked with the conveyor so that the stoppages automatically stop the painting operation and the restarting of the conveyor causes the painting operation to pick up where it left off without detriment to finish.

Colour changes can be made between bodies without interrupting production.

Eleven AAF multi-duty air filters with a total capacity of 912,000 cu. ft. per min. were supplied by Air Control Installations Ltd. for the air replacement plant serving all the Carrier spray booths. These filters are of the viscous impingement type, fully automatic in operation, self cleaning, and give constant air supply with the minimum of maintenance.

Flash Off

The bodies pass out of the spray booth into a sheet metal flash-off tunnel which connects the booth on the first floor to the primer surfacer oven and prevents shop dust being deposited on the painted surfaces.

Primer Surfacer Oven

This oven is located in the penthouse, and is heated by steam heater batteries and an air distribution system. A temperature of 300° F. is maintained and the baking time is 38 min. All external ducting carrying high-temperature air is suitably insulated to conserve heat.

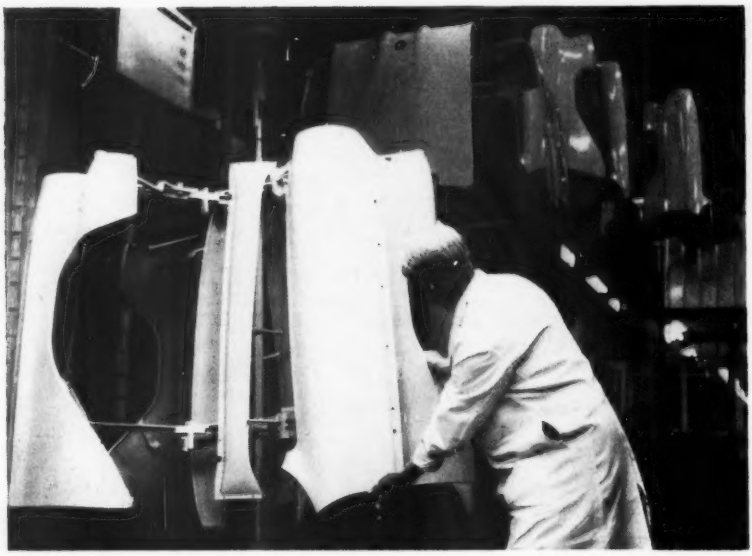


Fig. 10.—Inspecting sheet metal parts in the paint shop.

Sealing—2nd Stage (Underbody)

Descending from the penthouse stoving oven, the body now enters the underbody sealing section. Following masking at various points, the underside of the body shell is sprayed with a bitumen compound to a depth of approximately one-tenth in. This compound has the double effect of protecting the underside of the body as well as reducing drumming.

Wet Sanding

The wet sand oven is also located in the penthouse and is similar in all respects to the primer-surfacer oven except that the baking time is approximately 14 min.

The conveyor returns to first floor level, taking the bodies through a double-sided " Carrier " booth for spot spray of edges, etc.

Sealer Tunnel

The spot spray booth is connected to a sealer tunnel, where sealing compound is applied round floor sections and joints by pressure gun. The tunnel is constructed from steel and glass partitioning and is supplied with tempered and filtered air.

Colour Spray

Colour Tac-Rag

A steel and glass tack-rag enclosure precedes the monotone colour booth and is supplied with filtered, tempered and humidified air. It is equipped with vacuum-cleaning plant to prepare the body for colour spray.

Monotone Colour Booth

This " Carrier " booth is similar in all respects to the primer-surfacer booth, but is 150 ft. long and is supplied with filtered and tempered air of the correct humidity. There are three " Carrier-Schweitzer " automatic body-painting machines spaced such that the hand spray touching-in can be applied between coats.

Flash Off

A flash-off tunnel, as described for the primer-surfacer flash off, connects the booth to the oven above. It is supplied with warmed air to ensure the progressive heating of the bodies before entry to the colour oven.

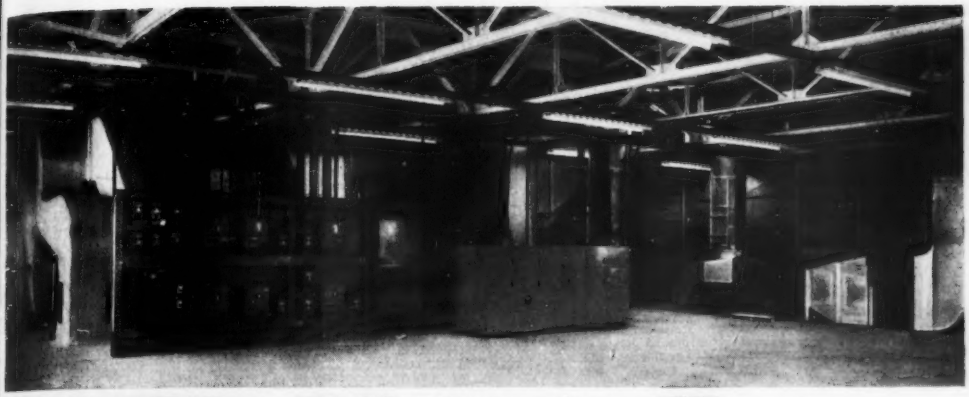
Monotone Colour Oven

After the colour-coat application, the body shell enters a flash-off tunnel on the way to the penthouse baking oven. This baking oven is constructionally similar to the primer-surfacer oven already described, but the heating equipment is served by high-pressure hot water and the temperature is maintained at 190° F., with a baking time of 28 min.

Polishing

Descending from the penthouse, the body is transferred to a conveyor running at floor level, which pulls the lightweight trucks upon which the body is mounted for its journey through the trim shop.

Although the major part of the body-polishing operations are carried out in the body-trim shop and after final assembly, on this short conveyor certain areas are polished. These areas are usually in the vicinity of applied mouldings. When this has been completed the body enters the trim shop, and is passed to a marshalling conveyor.



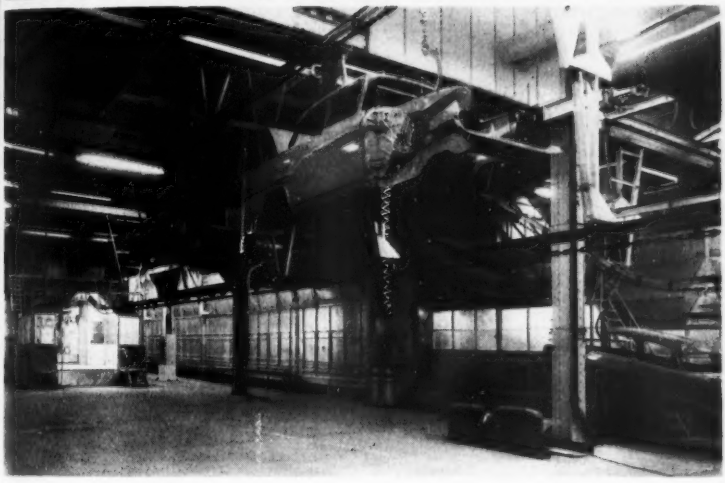


Fig. 11.—(above) Control panel with sheet metal ovens and heaters in the background.

Fig. 12.—(right) Entry to duotone spray booth (left), duotone transfer conveyor (centre) and exterior of colour tack-rag and monotone colour booths (background).

Duotone Painting

If bodies have to be processed in two-colour or duotone, they are then transferred to a separate overhead conveyor instead of the floor conveyor for the polish operation. The duotone tack-rag booth, flash-off tunnel and oven are supplied by Carrier Engineering and are described for the corresponding monotone equipment. The duotone booth, 90 ft. long, is equipped with two " Carrier-Schweitzer " body-painting machines and the rated output for the duotone equipment is half that of the main plant capacity.

High-pressure hot water is used to heat the colour oven to 180° F. for a baking time of 30 min.

SHEET METAL PARTS AND SMALL PARTS PAINTING

Part of the paint shop is set aside for the processing and finishing of those components of the body which are assembled in the trim shop and on the final assembly line.

This section of the paint shop is virtually two systems in one. Prepaint preparation methods are common to both systems, the process of Bonderizing and dipping in a tank of synthetic primer being used for all sheet-metal components.

The first and largest of the two systems deals with front wings, bonnets and front valances, and the second deals with small parts such as window mouldings, seat finishers, fillets and other small interior fittings.

Conveyor Systems

The entire sheet-metal and small parts painting plant is served by a system of conveyors. Apart from the sheet-metal transport conveyor which delivers components from panel store to paint shop, there are four conveyors for carrying components through the painting process, and one for polishing the bonnets and wings. The total length of these conveyors is approximately 2,821 ft. (just over half a mile).

Bonnet and Front Wings Transport Conveyor

Bonnets and wings reach the paint shop by means of a continuous overhead conveyor running from panel stores through the trim shop and on to the paint shop and then back to the panel stores. It is 2,268 ft. in length.

Phosphate Conveyor

On arrival at the paint shop, bonnets and wings are off-loaded and transferred to the phosphate conveyor which is 656 ft. in length. The operations carried out on this conveyor duplicate in miniature the processes employed in the case of the body shell, *i.e.*, cleaning, 6-stage phosphating (Spra-Bonderizing), and drying.

This automatic Spra-Bonderizing plant, designed by Newcombe-Detroit, is similar to that installed for the Bonderizing of bodies.

Sheet-metal Primer Conveyor

After Bonderizing, components are transferred (manually) to the primer conveyor (1,228 ft. long) which carries them into the 2,500-gal. dip tank, after which they are drained and flashed-off for a period of about 10 min. The entire plant is enclosed in a sheet-metal housing which is maintained at an air pressure a little above atmosphere. The fume and volatile extract is 20,000 cu. ft. per hour if thinners are used. The plant consists of the dip tank and a dump tank interlocked together, each having independent filtering, agitating and circulating systems. Both tanks incorporate the latest safety devices for the protection of this highly hazardous and flammable area. This duplicates the processes used for body shell pre-paint preparation. At this conveyor, small sheet-metal parts and large parts are placed on separate systems for colour coat application.

Large Sheet-metal Parts Colour Conveyor

The bonnets, wings and valances colour conveyor is 868 ft. long. Colour-coat application is by automatic Carrier-Schweitzer machines supplemented by hand-spraying. The conveyor carries the components to the penthouse for stoving, and then back to the paint shop for off-loading on to the polish conveyor.

Sheet-metal Polish Conveyor

Pad polishing by buffing machines is done on bucks which support the components. The bucks are mounted on trucks which are pulled around a 90-ft. continuous circular track.

Small Parts and Mouldings Conveyor

After Bonderizing, small parts are placed on the colour conveyor system, which incorporates spraying booths for colour (in enamel paint) and infra-red drying ovens. This conveyor system is 390 ft. long, and is contained in the paint shop, in a compact rectangular run, all at one level, there being no necessity to use the penthouse drying systems.

The plant, designed by Newcomb-Detroit, consists of two staggered single-sided spray booths, each 15 ft. long, with a flooding curtain for side-draught. The extract rate is 1,200 cu. ft. per min. per lineal foot, and the whole unit is contained in a sheet-metal housing. Air replacement is made through the roof at such a rate as to maintain a slight pressure inside the booths.

At the exit end of the booths is an enclosure where the paint is flashed-off for 4½ min. before entering the bake oven, which is designed for a 3-min. bake period at a temperature of 350° F. Radiant heating is used. At the exit end of the bake oven an automatic air cooler is installed to cool the components to allow manual handling.

Large Sheet-metal Parts Painting

This equipment, supplied by Carrier Engineering, comprises first a double-sided tack-rag booth, 10 ft. long, similar to the body tack-rag booth. This is followed by a single-sided spot spray booth and a steel and glass flash-off tunnel which is connected to the sheet-metal parts colour-spray booth.

The colour-spray booth is single-sided, 105 ft. long, and is equipped with a water curtain back plate. The booth is mounted over a water tank and the exhaust is of the water-washed type. A tank extension at the exit end of the booth houses screen filters specially designed so that they can be changed while the booth is in service. The booth is supplied with humidified, filtered and tempered air from a plant in the penthouse, and is lit by banks of fluorescent tubes located behind wired-glass panels. The paint lines are run outside the spray booth but within a special compartment running the full length of the booth with access to the paint and air line regulators through hinged, glazed doors.

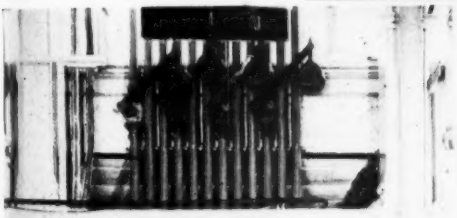
Automatic Colour Painting

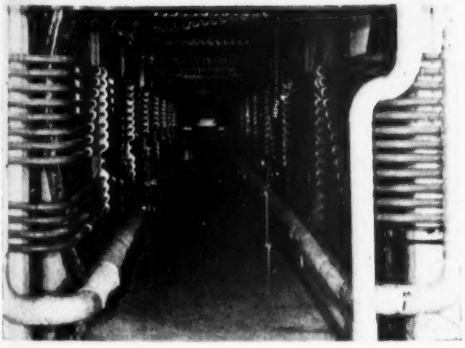
The paint is applied automatically by three " Carrier-Schweitzer " sheet-metal painting machines. For this purpose the goods are suspended on a circular frame from an overhead conveyor and are made to rotate immediately prior to each machine, and for the length of its station, by a friction drive installed in the roof of the booth. The direction of rotation is reversed after each machine.

As the work-holder approaches each machine and starts to rotate, it trips a switch and causes two spray guns, which are mounted side by side on the machine, to move vertically upwards. As the guns

Fig. 13.—(right) *General view of paint-mix room.*

Fig. 14.—(below) *Tunnel connecting paint-mix room to the paint shop, showing the paint distribution piping installed by Alfred Bullows and Sons Ltd.*





reach the bottom of the work the paint is turned on by an adjustable cam.

A combination of special cams and speed controllers cause the guns to follow the contour of the work and adjust themselves to the angle of spraying and speed of movement, so that an even film of paint is applied all over the work surfaces.

Only the upward stroke is a painting stroke, and after the process cam has turned off the paint at the top of the work the guns return to the bottom position, where they come to rest and await the next work carrier.

During the painting operation the machine itself travels in synchronization with the conveyor over the distance of its station. This is achieved by means of an hydraulic system which adjusts the speed of the machine to that of the conveyor and, at the same time, provides a rapid return to its " base " for the machine to pick up the next work-holder. In the event of a conveyor stoppage, provision is made for the painting cycle to be completed, and the machine will then trip its conveyor interlock and return to base.

During the dwell period after return to base, colour changing may be effected without loss of production.

Flash-off and Stoving

The goods now travel *via* a flash-off tunnel up to the sheet-metal bake oven, located in the penthouse, which is similar to the ovens previously described, and then return to the first floor level transfer point.

Petrol Tanks

Petrol tanks, which are fabricated on the ground floor of the body shop, are painted in a " Flo-Coat " installation manufactured by Heat and Air Systems Ltd. This plant, originally in K block, was re-installed in AC block, and was erected with new ducting for the fume exhaust. The plant also includes the necessary paint-drying oven and drain trays. The above company also supplied the tank required for the cleaning of plastic painting masks (used for " duotone " models) in a weak caustic solution.

Wheels

For the painting of wheels a 15-ft. long by 10-ft. wide by 7-ft. 3-in. high single-sided water-wash booth, together with a 30-ft. long flow-off corridor has been supplied by H. R. Noble Ltd. This plant is located in the basement of block AC.

THE PAINT-MIX BUILDING

Due to the large quantities of cellulose paints, thinners, solvents and other highly volatile and inflammable liquids used in painting operations, the bulk storage of these materials is centred in the paint-mix building adjacent to block AC.

With a floor area of 5,470 sq. ft., the building has been constructed with special regard to the prevention of fire. The floor is covered with an anti-static and spark-proof material. The temperature of the building is controlled at 70° F., and the ventilation and air-replacement plant housed on the flat roof ensures a constant change of air. The equipment inside the building consists of delivery tanks, pumping gear, and mixing machines, all installed by Alfred Bullows and Sons Ltd. All the lighting points are flameproofed, the electrical equipment is fully earthed and of the spark-proof type. The entire area is protected by sprinkler and foam systems.

Paint is delivered to the paint mix room in 40-gallon steel drums, weighing 5 to 6 cwt. according to the type of paint. A pedestrian-operated air-driven hoist and grab, with a monorail serving the gangways between the pumping gear and delivery tanks, has been installed to facilitate the handling of these drums.

Paints are mixed with thinners in the mixing and delivery tanks. The thinners is stored in three underground tanks located outside the building. A 5,000-gal. tank holds the cellulose thinners, a 3,000-gal. tank the synthetic paint thinners, and a 1,500-gal. tank the red-oxide primer paint thinners.

To establish the proportion of thinners to be mixed with each drum of paint it is necessary to determine the viscosity of the paint. Thus the drum is mounted in one of six tumbling machines and left turning end over end for 30 to 45 minutes. When thoroughly mixed, the viscosity reading is taken.

Pumping and Delivery System

The complete paint distribution installation consists of 18 individual paint circulating systems, all of which are fed from the central mixing house.

Each individual system, with the exception of the primer surfacer, consists of two paint-mixing tanks, each having a capacity of 100 gal., a horizontal piston pump and all the necessary interconnecting pipework, pressure gauges, self-cleaning paint-filters, etc., which are necessary to form a complete flow, and return paint circulating system.

The above mentioned 100-gal. mixing tanks are of a special nature, each being fitted with a reciprocating air motor which, due to its semi-rotary motion, gives a far greater degree of agitation than the usual rotary type. Also, these tanks are fitted with hinged lids for filling purposes and ventilation pipes have been fitted to atmosphere, thereby permitting the solvent vapours to escape.

As stated earlier, the paint in each of the systems, with the exception of the primer surfacer, is circulated by means of electrically-driven pumps, the capacity of these units being 600 gal. per hour maximum against a pressure of 125 lb. per sq. in. These pump units are of the totally enclosed double-acting self-oiling type having a crank speed at maximum flow of approximately 57 r.p.m.

Due to the abrasive nature of the primer surfacer material, it was necessary to instal an air-driven vertically mounted pump, running at the same speed as the horizontal units and having the same capacity at 75 lb. per sq. in. pressure. This unit is operated by means of compressed air at a pressure of 80 to 100 lb. per sq. in. As a precaution against pump failure, an additional unit is incorporated in this circuit as a standby. The pump units are so interconnected by pipework and valves, that either unit can be put into operation with a minimum of inconvenience or delay.

The 18 systems are made up as follows :—

12 lines of cellulose colour.
4 lines of synthetic colour.
1 line each of primer surfacer and primer dip.

Each paint line holds approximately 350 gal. of paint, thus together with the 100 gal. in the delivery tank, 450 gal. of paint must be put into the system before spraying can begin.

The routes for the various paint lines are as follows :—

Cellulose :
Mix room.
Small-parts painting section (paint shop).
Body-shell colour-spray booth (paint shop).
Large sheet-metal parts spray booth (paint shop).
Reserve spray booth (paint shop).
Rectify station (assembly line, final finish) and return to mix room.

Red-oxide Surfacer
Mix room.
Primer-surfacer spray booth (body shell) and return to mix room.

Dip primer (black synthetic)
Mix room.
Underbody dip tank.
Sheet-metal dip tank, and return to mix room.

Synthetic colour (for inferior sheet-metal parts)
Mix room.
Body-shell surfacer spray booth (special instrument-panel spraying operation).

Fig. 15.—(right) General view of the B.O. Morris horizontal straight-line polishing machines.

Fig. 16.—(left) One of the Canning automatic polishing machines for stainless-steel hub caps.

Small sheet-metal parts spray booth, and return to mix room.

The total length of the pipe lines, which are in 2-in., $1\frac{3}{4}$-in. and $1\frac{1}{4}$ in. dia. steel piping, is approximately 12 miles.

The cellulose colour lines each have 53 take-off points and the inside diameter of the pipe is 2 in. The synthetic colour lines have 4 take-off points each, the inside pipe diameter being $1\frac{3}{4}$ in. The primer-surfacer has 12 take-off points, again with an inside diameter of pipe of $1\frac{3}{4}$ in. ; and the primer dip has a take-off point at the dip tank itself for the maintenance of paint level, and the bore of this pipe is $1\frac{1}{2}$ in. An average length of each system would be approximately 2,500 ft., and the pipe used in all cases is solid-drawn mild steel.

There is also an additional pump unit incorporated in the primer-dip circuit as a standby unit, and again this is so designed that it can easily be put into operation should the need arise.

A salient feature of the pipework interconnecting the paint-mix tanks is that any of the four following arrangements can easily be adopted :—

1. Both tanks can be used either for mixing or circulation.
2. The paint may be pumped from one tank to the other direct.
3. The paint can be circulated through the complete pipeline and back into the same tank.
4. It provides facilities for emptying the com-complete system into containers.

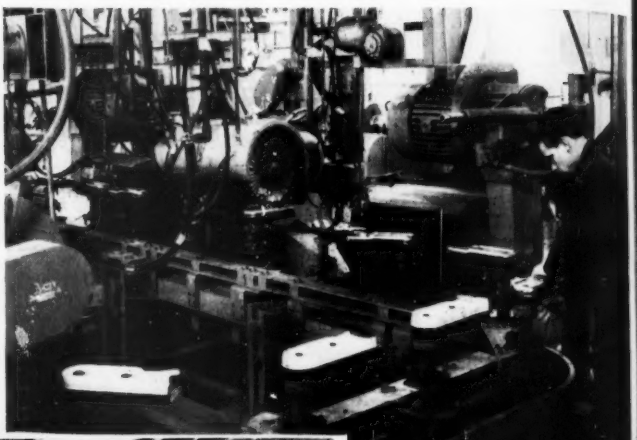


Fig. 17.—(right) General view of Acme polishing machine.

Fig. 18.—(left) Another B.O. Morris polishing installation.

In order to ensure a high quality of cleanliness of the paint being circulated, self-cleaning filters have been fitted at the commencement of each colour line. These filters are of the automatic cleaning type and therefore require the minimum amount of maintenance.

From the paint-mixing house, which is completely divorced from the main building, the pipework is fed to the paint shop through a tunnel which is in the form of a bridge from the mix house to the paint shop. The paint lines are fed through this tunnel structure and upon entering the building are distributed to the various paint-spray booths.

Each of the take-off points in the spray booths is complete with a sensitive fluid pressure regulator, the necessary hoses and spray guns.

In addition to this paint-circulation system, a complete cleaning system has been installed, consisting of centrifugal pump units, together with all the necessary pipework, to deliver the requisite solvent fluids from storage tanks positioned outside the main paint mixing room to each of the 100-gal. paint containers. There are three complete systems, one of which is for the cellulose line, one for the synthetic line and one for the primer-surfacer and dip materials. Each line is fitted with a flowmeter to regulate the supply of thinners to the tanks. These are positioned at various distribution points in the paint-mix house, and are conveniently placed so that all tanks can be fed quite easily.

The operators in the paint-mix room receive each day a schedule of production giving the number of vehicles and the sequence of colours to be used in the paint shop. In the case of red-oxide and black-synthetic paints, the number of vehicles only

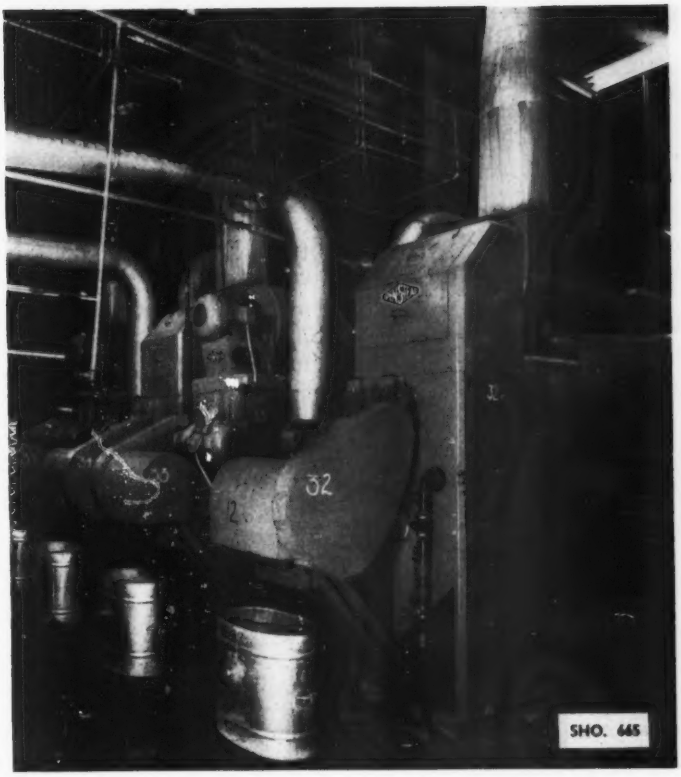


Fig. 19.—Hydrostatic dust arrestor on auto polishing line, installed by Spencer and Halstead Ltd.

affects quantities required. The mixing tanks are replenished direct from the 40-gal. drums, which are lifted by the hoist on to the monorail runway and tipped into the 100-gal. mixing tanks. The thinners is delivered by means of automatic metering hoses similar to those used in filling-station petrol pumps. The quantity of thinners can be preset on the metering and counting device, which automatically switches off the thinners delivery pump when the required amount has been passed through.

The controls for all the pumping gear are centred in one large control panel. Two men only are required to operate the system. Safety cut-off devices can be controlled either in the mix room or in every spray booth ; special valves in the pipe lines ensure safety in case of fire. These valves isolate the lengths of pipe in danger.

The whole of the installation is in accordance with the flameproof regulations laid down by General Motors.

POLISHING

Much of the polishing of metal components has been mechanized. The principle is the same for all types of automatic polishing. Components are clamped on to fixtures specially designed to hold them securely and without distortion. The fixtures are carried on a conveyor system which passes the component to a series of polishing mops mounted on universal heads. The heads can be placed in a number of positions to run statically, or they can be mounted on a counterbalanced device which permits the head to move in and out, or up and down, depending on the shape of the surfaces to be polished. Polishing mops are in some cases shaped to conform with the contours of components. Each polishing mop is provided with mechanical or electro-mechanical applicators which automatically cover the mop with the required amount of polishing lustre compound.

For the polishing operations generally, extensive use is made of abrasives manufactured by the Minnesota Mining and Manufacturering Co. Ltd.

In-line polishing machines can usually be operated by one man as the conveyor system is invariably designed to return the fixture loaded with its polished component to the loading station.

Rotary machines are of two types. On one, fixtures are mounted on self-aligning and self-indexing tables, with polishing mops positioned at

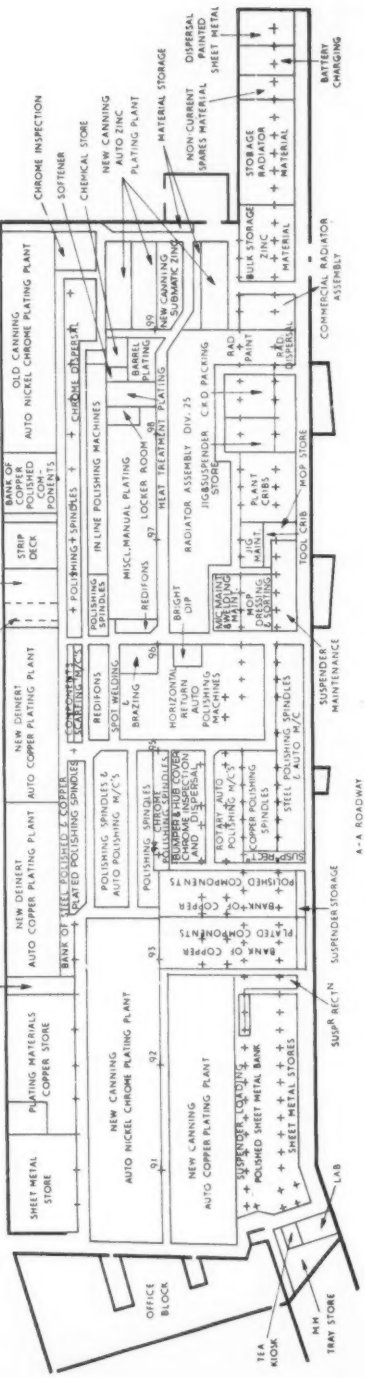


Fig. 20—Layout drawing of plating and radiator-assembly building (K block).

each station around the perimeter of the table. On the other, the conveyor system incorporates repositioning and oscillating devices at selected stations so that the various surfaces of awkwardly-shaped components can be presented to the mops in turn.

Components such as hub caps are mounted on rotating fixtures which operate in the reverse direction to that taken by the polishing mops.

There are three in-line continuous polishing machines, seven horizontal return automatic polishing machines, and eight rotary table-type polishing machines.

Manual polishing is also carried out in this shop on components which are copper-plated and on steel and brass pressings. Much use is now being made of band-polishing machines for hand-polishing operations. Most of this work is in the nature of a finishing-off process at points on components which are inaccessible to the mechanical polishers, and in preparing steel pressings, or copper-plated pressings for subsequent plating.

W. Canning and Co. Ltd. have supplied two automatic polishing machines for polishing hub caps after copper plating before nickel and chrome plating takes place. These machines are 96 in. dia. 10 spindle units, and each unit has two motors, one for indexing the table, the other for driving the spindles. Nine spindles rotate continuously while the tenth spindle, which comes into the loading/unloading station, is automatically disconnected for changing the work-piece. The indexing motion is timed to allow each polishing operation to be fully completed. At the end of the operation, the polishing head is automatically raised by a pneumatic system, the table indexes to the next station and the head is then lowered and polishing recommences. There are eight polishing heads to each machine—these are 7½-h.p. light follower units, each of which is fitted with automatic polishing composition applicators.

For the polishing of a variety of copper-plated components, B. O. Morris Ltd. have supplied the following machines : Three 6-head machines, one 18-head machine, one 8-head machine, and one 24-head machine. All these are of the horizontal return straight-line type. The company have also supplied a 40-in. 6-head rotary indexing machine with profiling attachment for the automatic polishing of vent frames and a similar machine for the polishing of hub caps.

An Acme rotary conveyor-type machine is also installed for the polishing of rear-light bezels.

Dust collection equipment has been installed by Dullow Lambert and Co. Ltd., and a total of sixteen hydrostatic dust arresters complete with fans and ductwork have been installed by Spencer and Halstead Ltd. on both auto- and hand-polishing equipment

PLATING

Plating operations have been considerably extended as part of the re-equipment and replanning programme. Now in K block and in a shop which formerly accommodated a great variety of different manufacturing operations, the plating (and also radiator manufacture) now occupies a total floor area of 251,540 sq. ft.

The functions located in this shop are as follows :—

1. Plating—copper, nickel-chrome, and zinc.
2. Polishing—sheet steel pressing, brass pressings, copper-plated, and stainless-steel components, by mechanical and hand methods.
3. Automatic soldering—Redifon induction heating equipment.
4. Radiator construction.
5. Storage of components in process.
6. Receiving and storage of plating materials.
7. Administration offices, inspection bays, maintenance cribs.

Automatic copper, nickel-chrome and zinc-plating plants of the most up-to-date type are to be found in this shop, a total area of approximately 65,740 sq. ft. being set aside for this work.

The major plants are :—

(*a*) Two Deinert automatic copper-plating plants (14,400 sq. ft.).

(*b*) A Canning auto. nickel-chrome plating plant (9,120 sq. ft.).

(*c*) A new Canning auto. nickel chrome plating plant (18,200 sq. ft.).

(*d*) A new Canning auto. copper-plating plant (12,650 sq. ft.).

(*e*) Three Canning auto. zinc-plating plants (8,250 sq. ft.).

(f) Barrel plating and heat-treatment plating plants (2,750 sq. ft.).

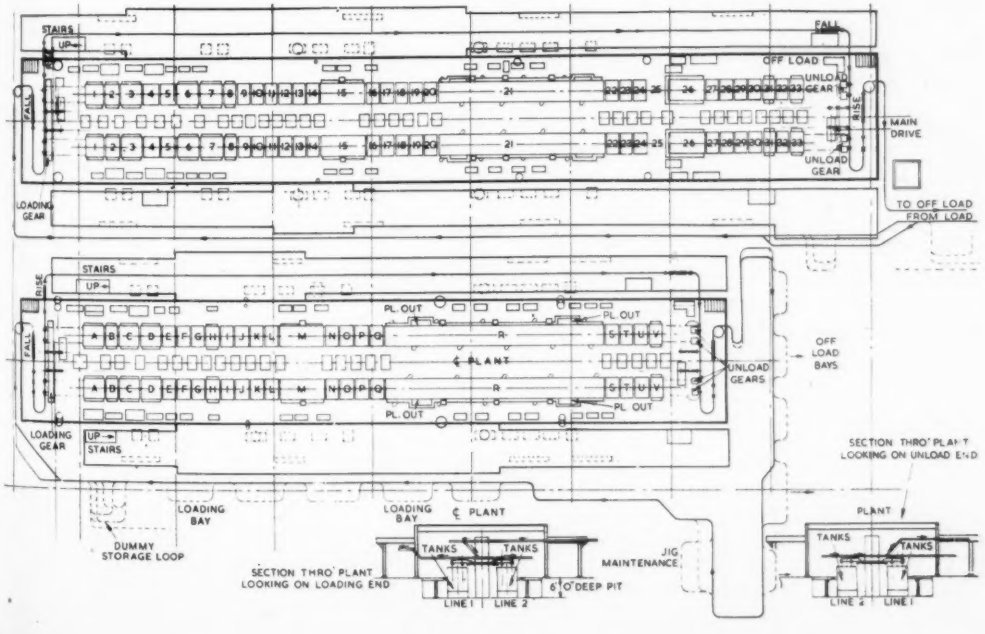
(*g*) Manual plating plants for copper, nickel and chrome (8,100 sq. ft.).

The two Deinert copper-plating plants were

Fig. 21.—Layout of the two new Canning automatic plating lines

(Top) Nickel-chromium : (1) Caustic anodic clean ; (2) Power spray swill ; (3) Power spray clean ; (4) Neutralize ; (5) Spray swill ; (6) Cathodic hot cleaner ; (7) Cathodic cold cleaner ; (8) Anodic Cleaner ; (9) Drag-out ; (10) Drag-out ; (11) Cold swill auto-spray; (12) Acid dip; (13) Auto-spray swill; (14) Cyanide dip; (15) Cyanide copper; (16), (17) Drag-outs; (18) Auto-spray swill ; (19) Acid dip ; (20) Spray swill ; (21) Bright nickel plate ; (22), (23) Drag-outs ; (24) Drag-out auto-spray ; (25) Inspect ; (26) Chromium plate ; (27), (28) Drag-outs ; (29) Neutralize ; (30) Auto-spray swill ; (31) Hot swill ; (32) Auto-spray swill ; (33) Hot swill

(Bottom) Copper : (A) Power spray swill ; (B) Power spray swill ; (C) Hot cathodic alkaline cleaner ; (D) Cold anodic alkaline cleaner; (E) Warm swill and spray; (F) Drag-out; (G) Cold swill; (H) Acid etch; (I), (J) Drag outs; (K) Cold swill; (L) Cyanide dip; (M) Cyanide copper plate; (N), (O) Drag-outs; (P) Cold auto-swill; (Q) Acid dip; (R) Acid copper plate; (S), (T) Drag-outs ; (U) Cold auto-spray swill ; (V) Hot swill



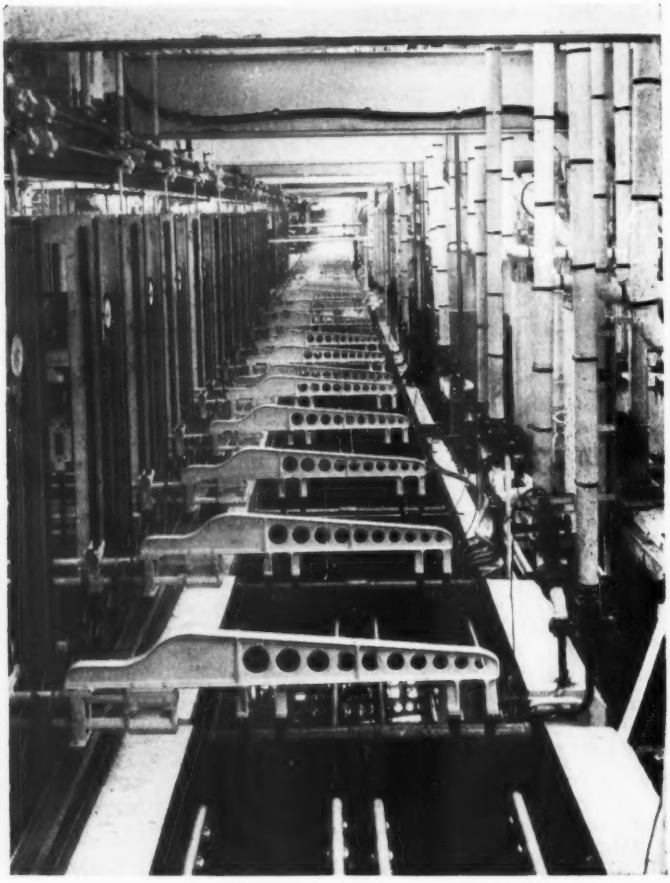


Fig. 22.—(left) General view taken along one side of the Canning automatic nickel-chrome plant.

Fig. 23.—(facing page) Rectifiers on gantry over Canning plating line.

the first of the larger installations to be put into operation. The new Canning plants were given their first proving trials in April, 1958.

CANNING PLATING PLANTS

Copper, Nickel and Chromium Plating

The Canning installation, which is for the copper, bright-nickel and chromium plating of steel pressings, is in two sections ; the first section applies a heavy copper deposit which is polished prior to being conveyed back to the bright-nickel and chrome section of the installation from which components are passed directly to the assembly lines.

Each unit is designed to handle 100 jigs per hour, each jig being loaded with approx. 8 sq. ft. area of components ; 200 jigs per hour is the total throughput, equivalent to 1,600 sq. ft. of plated work.

There are many unique design features incorporated in order to ensure complete automation as far as plants of this type have developed, *e.g.*, duplex main drives to reduce the drag load on the main conveyor, automatic lubrication for conveyor chains and contact track, automatic load and off-load, provision for chemical make-up remote from the process tanks, and a general control from control rooms built on an upper platform.

Essential details of the two plants are as follows:—

Heavy Copper-Plating Plant

Overall length	217 ft. 6 in.
Overall width	60 ft.
Overall height	23 ft.
No. of tanks	22 ft.

Bright Nickel and Chrome Plant

Overall length	262 ft.
Overall width	60 ft.
Overall height	23 ft.
Cleaning processes :	tanks 1 to 20
Nickel	,, 21 to 24
Chrome	,, 26 to 33

The complete electrical installation for the two lines covering the erection of three 1,000 KVA transformers with associated cabling, H.T. and L.T. switchgear, and also the control switchgear contactor panels and terminal boxes, and further, the installation of all circuit wiring and control cabling, was carried out by Holliday Hall and Stinson Limited.

Heavy Copper Plating Plant

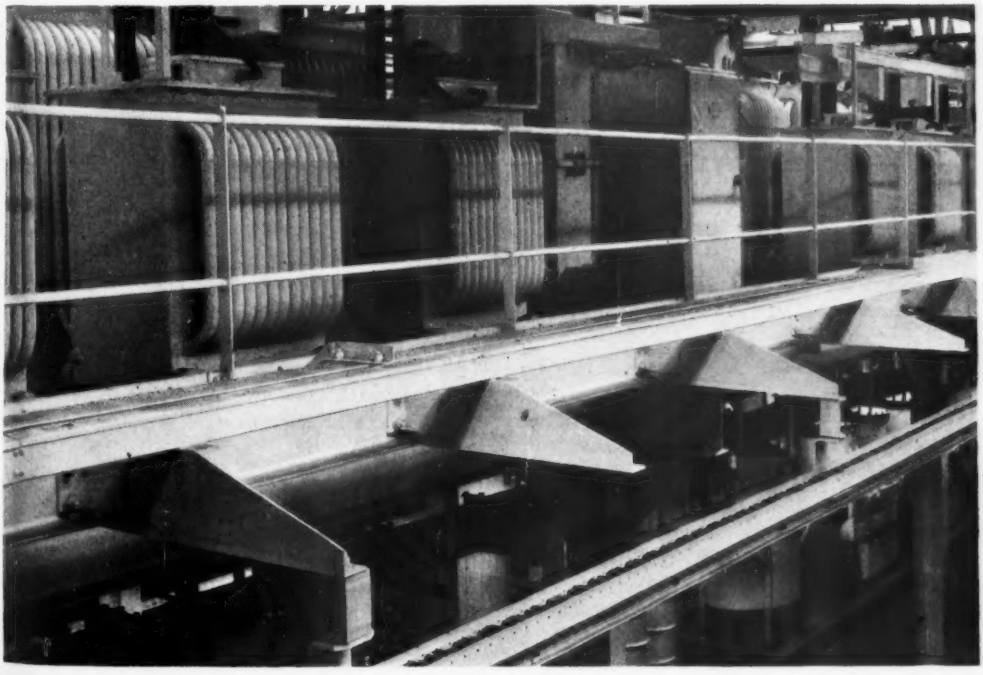
This straight-through automatic unit occupies approximately 13,000 sq. ft. of floor space. Two rows of 22 process tanks lie parallel to each other, 9 ft. apart.

Around the plant is erected a massive steel-girder structure which supports the conveyor system, rectifiers, transformers, and storage tanks and the platform and cat-walks for the plant operators. The cat-walks pass between the tanks at ground level and also at a high level above the supporting girder towers.

The Conveyor System

A conveyor system runs between the two rows of tanks supporting a series of flight bars which extend over the tops of the tanks on either side. There are 138 flight bars spaced on a twin-strand link conveyor and held in position by flared U-shaped plates attached to links in the conveyor. During plating, the bars are carried by the conveyor on hard-drawn, high-conductivity copper track above the tops of the process tanks from one end of the plant to the other. At the discharge end, the conveyor carries the flight bars upwards and back over the length of the plant to the loading end.

The conveyor system is operated by a system of 23 elevator towers spaced between the parallel rows of tanks. The towers are fitted with a carriage and when a flight bar approaches a transfer station a limit switch is operated. This sets the elevator motor in motion. The carriage is controlled and moves up the tower lifting the flight bar with it. At the end of the travel a limit switch operates and checks the movement. The next part of the operation is to slide the flight bar forward. This is done by a separate system and the distance moved is sufficient to clear the lips of the abutting tanks and allow the jigs to be lowered cleanly into the next process tank. When the flight bar reaches this position, the lift motor reverses and the elevator is lowered, placing the bar back on the moving conveyor, the speed of which is 12½ in. per min. The jigs are fitted with conical heads which mate into conical seatings in the flight bars. Two jig loads are accommodated on each side of the flight bars.



Auxiliary Conveyor Loading and Unloading Units

Serving the main conveyors are auxiliary conveyors. These are of a special cycle-controlled type (Geo. W. King, Ltd., " Stanrun "). Their function, in addition to feeding the process conveyor with loaded jigs and receiving the plated work, is to present and accept the jigs at the automatic loading and unloading machines. Finished work from the polishing section is passed to the loading bays. There are five bays and each handles a particular group of articles. The auxiliary or feeding conveyor has a series of trolleys which are brought on loops into the loading bays. Here they are loaded with jigs which have been filled with the polished work. They are then moved through the loops on to the conveyor which transports them to a storage point before the loading unit. At the correct time, a pulse is received from the plant control and four jigs are carried by the trolleys to the loading position. At the correct point they are stopped and four pairs of arms from the loading unit lift the jigs off the conveyor and place them on the flight bars of the plating plant conveyor.

The empty trolleys then by-pass the plating plant and are then brought to the discharge end of the process line. Meanwhile, four jigs of processed components are at the discharge end of the plating line. These are lifted by the unloading unit—rotated through 180 deg. and placed on to the trolleys of the conveyor. At a signal, the trolleys are moved along the conveyor to the unloading bay. Each trolley selects its appropriate bay where the components are removed from the jig. The trolley and empty jig then returns to the line and pass through to the loading bay.

Thermostatic control is fitted to all heated tanks.

Storage, Pumping and Filtration

17,000 gallons of copper solution are stored in three rubber-lined tanks. These solutions are passed to the process tanks by rubber-lined pumps through filters which can deal with 12,000 gal. of copper solution per hour. In addition, there are eight mixing tanks for the various cleaning and other solutions used in the plant.

Current

The current available for the electrolytic processes totals 71,000 amp. Current is taken from the mains and transformed by banks of oil-immersed metal plate rectifiers. There are 20 rectifiers, 12 of them motorized giving infinitely variable control. Current is fed to process tanks *via* aluminium busbars. Current for the electrolytic operations is passed to components *via* the flight bars which in turn collect current from the H.D.H.C. copper track beside the main conveyor.

The entire electrolytic installation is controlled at one point at the central control panel. The conveyors, pumps and filtration equipment have separate control points on the panel.

Table I
Canning Copper Plating Sequence

Plating sequence process	Immersion time	Tank lining	Stage
	min.	—	
1. Power spray cleaner ..	2½		Cleaning
2. Power spray swill	½	Lead	,,
3. Electrolytic cathodic cleaner (Anodax)	2½	—	,,
4. Cold electrolytic cathodic cleaner (Anodax)	2½	—	,,
5. Warm swill and spray ..	½	Rubber	,,
6. Dragout	½	,,	,,
7. Cold swill and spray ..	½	,,	,,
8. Acid dip	½	Lead	,,
9. Dragout, swill and spray ..	½	Rubber	,,
10. Dragout, swill and spray ..	½	,,	,,
11. Cold swill and spray ..	½	,,	,,
12. Cyanide dip..	½	,,	,,
13. Cyanide copper plate (Cuprax)	10	,,	Cyanide copper plate
14. Dragout, swill and spray ..	½	,,	,,
15. Dragout, swill and spray ..	½	,,	,,
16. Cold swill and spray ..	½	,,	,,
17. Cold swill	½	,,	Acid
18. Acid copper plate (Sulfast)	60	,,	copper plate
19. Dragout swill	½	,,	,,
20. Dragout swill	½	,,	,,
21. Cold spray and swill ..	½	,,	,,
22. Hot swill	½	Lead	,,

Nickel and Chromium Plating Plant

The design of this plant is generally the same as the heavy copper installation. It is slightly larger, occupying approximately 18,000 sq. ft. of floor space. The plating tanks are in two parallel rows 9 ft. apart ; 32 tanks make up each line.

Arrangements of the conveyor system is identical and it uses 168 flight bars. The plating installation is also served by auxiliary conveyors and has automatic loading and unloading units.

Current from the rectifiers totals 111,000 amp., and output of the plant is 100 jigs per hour, each jig having 8 sq. ft. of cathode area giving 800 sq. ft. of plated surface per hour.

The tanks which contain the heated solutions are thermostatically controlled.

Conveyor System

This is fitted with 34 lift towers spaced along the 9 ft. passage between the two rows of process tanks. Operation is the same as the conveyor on the copper-plating plant.

Auxiliary Conveyors

These are the same as the conveyors serving the copper plant and present and accept loaded jigs at the automatic loading and unloading machines.

Storage, Pumping and Filtration

13,000 gal. of nickel solution are stored in three rubber-lined tanks. The solution is passed to the process tanks by rubber-lined pumps through

Table II

Canning Ni-Cr Plating Sequence

Plating sequence process	Immersion time	Tank lining	Stage
	min.		
1. Caustic anodic cleaner (Anodax)	1¾	—	Cleaning
2. Power spray swill	¼	Lead	,,
3. Power spray cleaner (Anodax)	3	—	,,
4. Neutralize	1¾	Rubber	,,
5. Spray swill	1¾	,,	,,
6. Cathode hot cleaner (Anodax)	3	—	,,
7. Cathode cold cleaner (Kleen-well)	3	—	,,
8. Anodic cleaner	½	Rubber	,,
9. Dragout	½	,,	,,
10. Dragout	½	,,	,,
11. Cold swill	½	,,	,,
12. Acid dip	½	,,	,,
13. Spray swill	½	,,	,,
14. Cyanide dip	½	,,	,,
15. Cyanide dip	10	,,	,,
16. Dragout	½	,,	,,
17. Dragout	½	,,	,,
18. Spray swill	½	,,	,,
19. Acid dip	½	,,	,,
20. Spray swill	½	,,	,,
21. Bright nickel (Gleamax)	45	,,	Nickel plate
22. Dragout	½	,,	,,
23. Dragout	½	,,	,,
24. Spray swill	½	,,	,,
25. Inspection			
26. Chrome plate (Zonax)	7	Lead lined & tiled	Chrome plate
27. Dragout	½	Lead	,,
28. Dragout	½	,,	,,
29. Neutralize	½	—	,,
30. Spray swill	½	Rubber	,,
31. Hot swill	½	Lead	,,
32. Spray swill	½	Rubber	,,
33. Hot swill	½	Lead	,,

filters capable of handling 6,000 gal. of solution per hour.

There are 21 mixing tanks for the cleaning and plating solutions.

An interesting feature of the nickel filtration system is the removal of metallic solution contaminants by low-current-density plating out. This comprises two " blister " compartments on the main tanks through which the solution is continuously circulated.

Current

Current totalling 111,000 amp. is supplied by 30 rectifiers, 12 being motorized to give infinitely variable control. The entire electrolytic installation is controlled at one point on the central control unit. Conveyors, pumps and filtration equipment have separate control points.

Some additional Features of Both Plants

Both plants have been designed to conserve water and to assist this aim the swills counterflow. Double dragouts are provided and the drain channel system has been so designed that there is no problem from mixed effluent.

The filters on the plant are arranged in banks, each filter pot being about 1,000 gal. capacity; each section of the filter system is complete with its own wash deck and hoist. There is a change of solution about every two hours.

Refrigeration is provided for the chromium vats and also for the acid copper if required, the cooling being external to the processing tanks by means of a heat exchanger.

Safety devices on the plants are very comprehensive. Heenan and Froude drives on the plating conveyors protect the plant with over- and under-speed relays ; these drives also incorporate shear pins. Emergency stop-buttons connected in series are provided at many points around the plant, and trip wires are installed in the tank pits. On the traverse mechanism there is also an overrun switch, and emergency stop buttons are also provided above the gearboxes on the traverse tracks at the top of the towers. A pressure switch is fitted to each filter and level switches to all tanks. Failure of any part of the plant is shown by colour lights in the control room. Tank heating is by high-pressure hot water.

Zinc Plating

Zinc plating is carried out in two plants. One in a Canning heavy return-type electro-hydraulic automatic unit ; the other a Canning " Submatic " semi-automatic barrel plant.

Return-type Automatic Unit

This is a two work line installation, 70 ft. in length. It has an output of 120 work jigs per hour and is engaged on plating steel brake fittings. The operating mechanism is carried by a steel centre structure and the plating tanks are ranged around. Lift, lower and traverse is by hydraulic gear which is electronically interlocked to ensure perfect timing of the plating process. The whole plant is under the supervision of one operator who loads and unloads the jigs of work. The plating sequence is shown in Table III.

Table III

Automatic Zinc Plating Sequence

Process	Immersion time	Tank lining	Stage
	min.		
1. Cleaning (Anodax)	3½	Mild steel	Cleaning
2. Cleaning (Anodax)	3½	,,	,,
3. Warm spray swill	½	Rubber	,,
4. Sulphuric-acid pickle (10 per cent Sol. 100° F.)	20½	,,	,,
5. Dragout	½	,,	,,
6. Dragout	½	,,	,,
7. Cold spray swill	½	,,	,,
8. Cleaner (Cyanide-caustic-anodic)	4½	Mild steel	,,
9. Zinc plate	25½	Rubber	Zinc plate
10. Dragout	½	,,	,,
11. Dragout	½	,,	,,
12. Cold spray swill	½	,,	,,
13. Hot swill (180° F.)	1½	,,	,,

Fig. 24.—Some of the many components which are electroplated at Luton, laid out on the run-out inspection table.

Thermostatic control is fitted to all heated tanks.

Electrical power for the process is supplied by rectifiers which have a total output of 16,500 amp. An overhead platform positioned at side of the plant carries the solution storage equipment and fume-extraction fans. Below the platform are the rectifiers and filtration equipment and switch loads.

Submatic Plating Plant

This installation is 36 ft. long and comprises 10 separate tanks in line in a steel frame. It is for zinc plating a wide range of small components too small for handling through the automatic unit.

Four ebonite barrels, each of 100 lb. capacity, are used for processing the work through the line. The barrels are lifted and traversed by a monorail hoist fitted with a pendant control. The plating sequence is shown in Table IV:

Table IV. Submatic Zinc Plating Sequence

Process	Tank lining	Sequence
1. Hot cleaner (Anodic (160° F.)	Mild steel	Cleaning
2. Cold swill	Rubber	,,
3. Acid dip (10 per cent H_2SO_4)	,,	,,
4. Cold swill	,,	,,
5. Cyanide dip	Mild steel	,,
6. Zinc plating	Rubber	Zinc plating
7. Dragout	Mild steel	,,
8. Dragout	,,	,,
9. Cold swill	Rubber	,,
10. Warm swill	Galvanized	,,

All heated tanks are thermostatically controlled. Current for the electrolytic processes totals 2,500 amp.

Drive is by chain from a master motor unit to each barrel station. On lowering the barrel to its process tank the driving gear engages automatically.

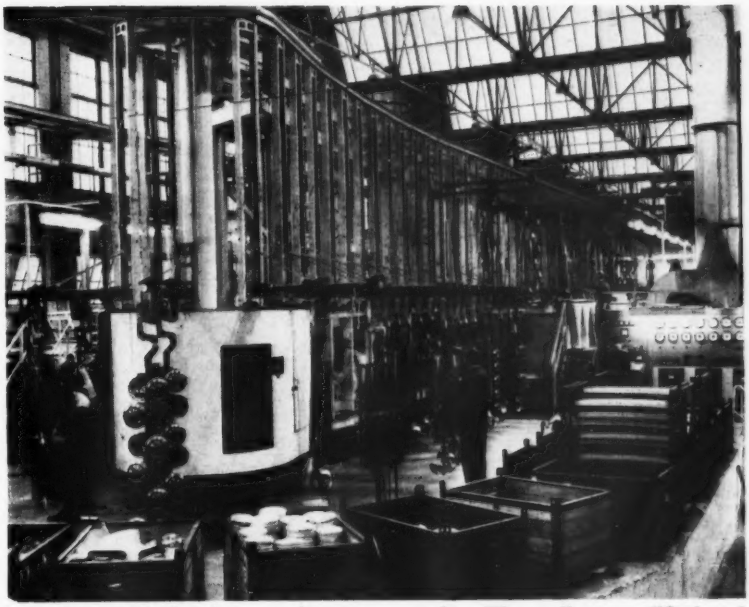


Fig. 25.—General view of one of the Deinert plating plants.

Each station has individual clutch control, thereby enabling barrels to be engaged and disengaged individually.

Three barrels can be processed simultaneously in the zinc tank and two in the hot cleaner. At these stations each barrel has individual current control.

Process timing is arranged to give both audible and visual warning. Exhaust equipment is fitted to those tanks which fume, and the barrels are also exhausted while in the lifted position by an exhaust lip on the half hood. After processing, the barrels are discharged into a hopper in the hot swill tank. The hopper in turn discharges into one of the two centrifugal dryers for final drying.

The zinc storage tank for this plant has a capacity of 800 gal. It is on the steel structure which is common to both the " Submatic " and the zinc return plant. Filtration equipment and switch gear are below the storage tanks.

Deinert Plating Plants

The Deinert machines are identical in size and capacity, and consist of a series of 22 process tanks placed in a narrow oval circuit around the central conveyor system. This conveyor is a two-strand chain driven by sprockets. The two chain stands are spaced one vertically above the other, the drive sprockets being linked by a common spindle. Pairs of vertical guide rails act as spacers as well as tracks for raising and lowering loads of components. Wheeled trolleys carrying components-loaded flight bars which extend outwards over the process tanks run up and down the vertical guide rails according to the process cycle. The trolleys are lifted and lowered by means of hydraulic lifting bridges. The transfer of component-loaded frames from one process tank to the next is accomplished by a combination of lifting by the hydraulic bridges, horizontal movement by the central chain conveyor system, and lowering by the hydraulic bridges.

Agitation of components while immersed in the process tanks is effected by an independent mechanical system which raises and lowers the flight bars a distance of approximately 10 in.

The capacity of these plants is 8 sq. ft. of plating per jig-load, and 48 jig-loads are delivered per hour, giving a total output of 384 sq. ft. of plating per hour.

These plants are completely automatic in operation. A central control panel establishes and maintains the process cycle. The only manual operations are loading and unloading the components on to the frames.

The copper-plating process in detail is as indicated in Table V :—

The components treated in these plants are sheet-metal pressings, and include hub caps, bumper bars, radiator grilles, bonnet flutes, " no-draught " window mouldings, and window division channels.

Fig. 26 shows the main mechanism of the plant. The lifting bridge (E) is actuated hydraulically by the cylinder (F) ; raising the bridge raises the carriers within the vertical guide rail (C). When the piston is in the raised position, the pump stops and a non-return valve prevents the oil from flowing back into the storage tank.

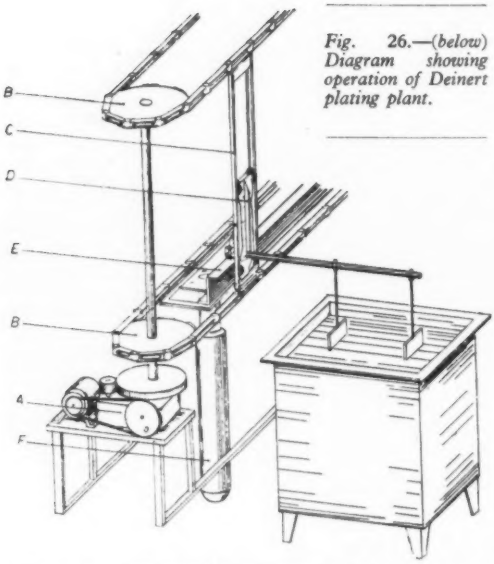


Fig. 26.—(below) Diagram showing operation of Deinert plating plant.

Table V

Tank No.	Process	Temperature, °F.	Tank capacity, gal.
1	Alkaline cleaning	194	1,980
2	Water spray	cold	660
3	Cathode degreasing	150	320
4	Anodic degreasing	90-100	660
5	Drag out	—	660
6	Drag out	—	660
7	Cold swill	—	660
8	Acid dip	Room temp.	660
9	Drag out	—	660
10	Drag out	—	660
11	Cold swill	—	660
12	Cyanide dip	70	660
13	Alkaline copper	140-170	660
14	Drag out	—	660
15	Drag out	—	660
16	Cold swill	—	660
17	Acid dip	Room Temp.	660
18	Acid copper	100-120	14,520
19	Drag out	—	660
20	Drag out	—	660
21	Cold swill	—	660
22	Hot swill	—	660

For the downward movement of the bridge a magnetically operated valve is opened and the bridge descends under its own weight, speed being controlled by a regulation device. The downward movement of the bridge is intiated only after the central conveyor system has imparted a horizontal movement to the flight bars.

The central conveyor is driven through gearing (A) by an electric motor. The two sprocket wheels (B) are connected by a fixed shaft. The two endless chains parallel to one another pass over the sprocket wheels, and the carrier guide rails which are fixed vertically between the chains return the carriers. A hydraulic device shortens the immersion time of the carrier.

The guide frame consists of two U-shaped rails which are joined to each other through connecting pieces at the top and bottom of the carrier guide frame ; 68 guide frames are attached to both endless chains. There is a roller at the bottom of each guide frame. The distance between each of the guide frames, that is to say, the distance between the two flight bars, is equal to the length of one tank cycle. The rollers run on a rail fixed to the supporting structure and which goes all round the plant. Each flight bar is equipped with two conical inset cups for suspending the plating jigs as well as three spring contacts.

In between each process tank and its running swill there are two static dragouts in order to reduce the load on the works' effluent treatment plant. The plating-out tank originally provided in the tank layout is not used for this purpose but

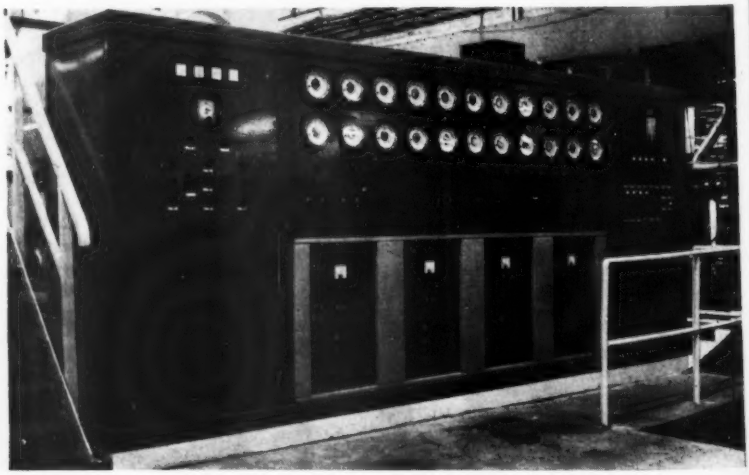


Fig. 27.—Control panel for Deinert plating plant.

Fig. 28.—Luton trade effluent plant under construction.

is connected by pipes to the main plating tank and is now used for chemical additions.

As can be seen from the photographs of the plant, there are three rubber-lined storage tanks of 11,000-gal. capacity provided for acid copper solutions. One tank is provided for cyanide copper storage ; this has a capacity of 4,000 gal. Plating solutions can be pumped up to the storage tanks and returned through filters (supplied by W. Canning and Co. Ltd.) or direct. Filtration of the acid-copper solution is through paper ; continuous filtration through carbon is used for the cyanide copper. Two storage tanks are installed for sulphuric acid.

All tank heating is by high-pressure hot water, and refrigeration is available for the acid-copper tanks. Adequate air supplies are available for agitation, etc., if required. Transformers and rectifiers (Canning—Westalite) were supplied by W. Canning and Co. Ltd.

An interesting feature of the plant is that all the suspenders can be raised to the top gantry above the bridge so that the tanks are unimpeded for cleaning. Sulphuric-acid additions are made by a stainless-steel injection pump.

The Deinert cleaners are supplied by Silvercrown Ltd. The cyanide-copper solution is the original Deinert solution which has been maintained by Vauxhall, and the acid-copper solution is the company's own formulation ; it contains thiourea to produce a fine-grained deposit which is easy to polish.

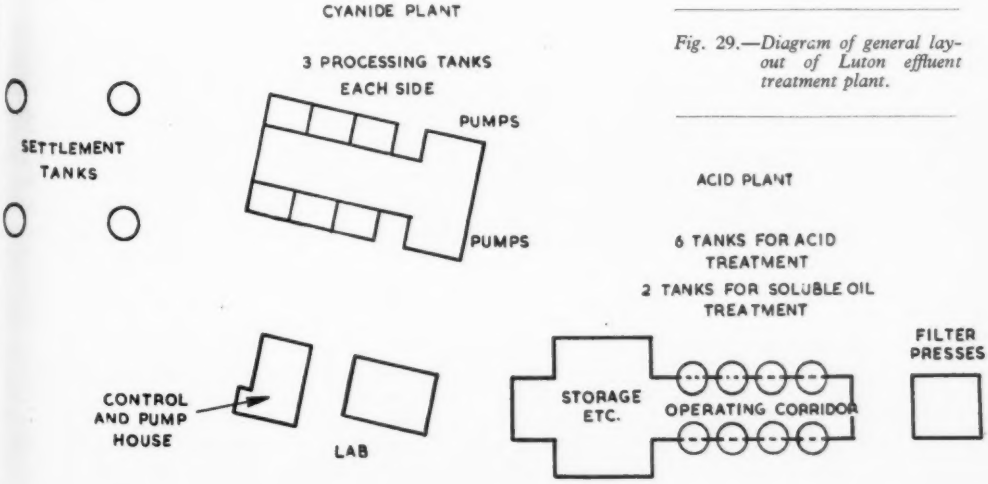


Fig. 29.—Diagram of general lay-out of Luton effluent treatment plant.

Fig. 30.—(right) Operating corridor of cyanide treatment plant.

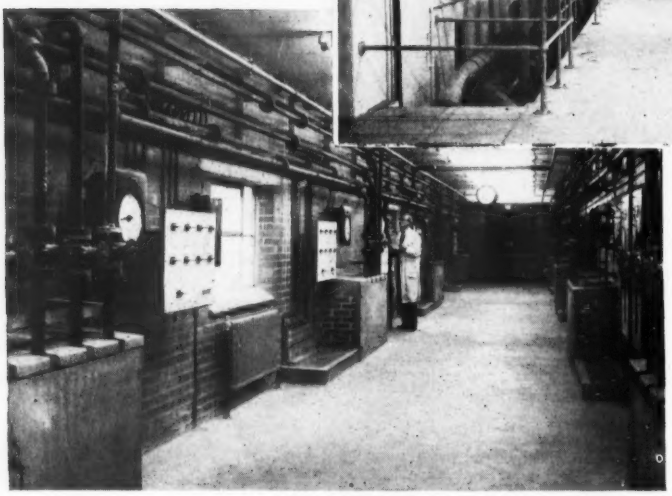


Fig. 31.—(left) Operating corridor of acid treatment plant.

EFFLUENT DISPOSAL

One of the most important aspects of the new extensions has been the necessity to provide adequate facilities for effluent disposal. As previously mentioned, the plating plants have been designed with double-drag-outs, and throughout the works plant has been designed to conserve water as much as possible. The regulations laid down by the Luton Corporation for effluent disposal are very stringent, and therefore the plant erected at the works has had to be very comprehensive and efficient.

In addition to the plant itself, located at some distance from the works, adequate drain systems and pumping stations have had to be provided in the main works.

There is one pumping station at the north end of K block, and another about half-way down the east side of this block. The north station is an older installation and the drains served the Canning automatic plating plant which has been in operation for some years.

The new K block pump station serves the Dienert and the remainder of the new plating shop. A third pumping station is located in a basement at the south-west corner of AA block. A 4-in. drain runs from AA block, but from K block all the drains are 6 in. dia.; altogether the drains run for a distance of ½-mile. The drains for the plating shop are of chemically resistant stoneware jointed with Furane cement. In general, the materials used for all the drains, etc., have been chosen to have good all-round resistance to chemicals. This is because in the past so many changes were taking place, comparatively rapidly, that it was often necessary to put acid in a drain that previously had carried alkali. The recent installations, however, have drains for the separate liquors, but in most cases of identical materials.

The apex of the drains is located in the plating shop ; there are three drains in each direction, one for acid and one for alkali (cyanide) and one spare. The last 120 ft. of each drain is in pitch-fibre pipe from K block, and one length of the drain system from K block to the right-hand pump station is bored and one length tunnelled.

The system as a whole treats liquors which would break the company's agreement with Luton Corporation, which virtually requires pure water to be discharged to the sewer ; liquors include cyanides, acids and soluble oils. Liquors which

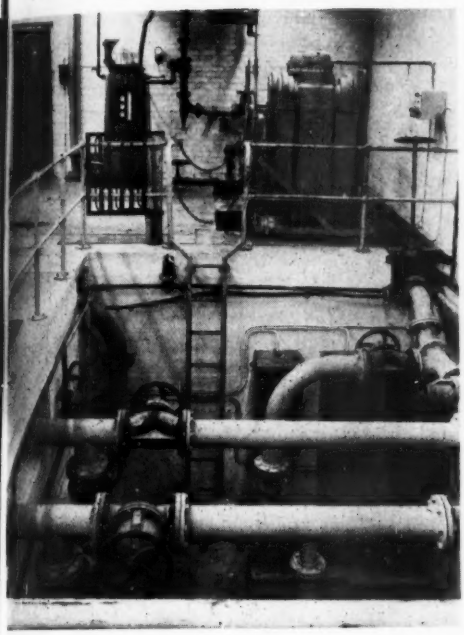


Fig. 32—One of the chlorinators and pumps in the acid treatment plant.

cannot be classified as either cyanide or soluble oil are treated as acids. Bonderite wastes, for example, are delivered to the acid plant in tankers, as are most of the wastes from other parts of the works.

In AC block, cyanide and acid drains have been laid which connect up to the pump house north of K block. Although cyanide is at present not used in AC block, the installation was made during erection of the building in case of future need.

Dump tanks are located in some parts of the works for disposal of wastes which are then collected by tanker. In other parts, tankers collect direct from the plant. The tankers discharge their loads into either of the K-block pumping stations.

The waste liquor received from other parts of the works include Bonderite, Parco-Lubrite, pickling, chromate, rinses, soluble oil from machines and washing machines ; some of these contain caustic soda and also emulsified oil as well as free oil from the machines themselves.

In AA block the pumping station is equipped with Monopumps of rubber construction ; the K-block pumps, however are Hayward-Tyler-Barr and Jackson centrifugal pumps of stainless-steel construction. (These pumps are made under licence by Barr and Jackson from the U.S. manufacturers.)

The acid sides of the pumps have rubber-lined pipes for suction and delivery and all the way to

Fig. 33. General view of chlorine store.

the treatment plant. The cyanide mains are cast iron.

At Dunstable, soluble oils are pumped to the treatment plant at that works, but at Luton they are collected by tanker. However, at Dunstable cyanide and acids are collected, whereas at Luton they are pumped.

The general layout of the treatment plant is shown in Fig. 29.

In addition, there are four settlement tanks to which liquors are discharged and from which the settled liquor is discharged to the sewer and settled sludges pumped to the filter-press house for dewatering. The filter presses are on the roof of the building and discharge the pressed sludge *via* hoppers into a lorry below. Pumps are housed in the enclosed part of the building either side of the lorry loading bay. The dewatered sludges, in the form of hydroxides, are transported to the Corporation tip.

At Dunstable the treatment plant is similar to Luton but smaller. The exception is the soluble-oil plant in which treatment is effected with salt. At the Luton plant the soluble oil is treated with acid and is virtually part of the acid treatment plant, although the treatment is *not* by acid wastes. This location has been chosen solely because the acid plant also incorporates the acid stores, and therefore handling of acid is facilitated.

Cyanide Treatment

There are three 12,000-gal. tanks each side of the cyanide building, making two separate self-contained plants. There is, in each section, separate suction from each tank into a common main which circulates round the building and back to the tanks. Chemicals are injected by special pumps into the delivery side of the pipe line. The sequence follows :

Ram pumps inject NaOH (50 per cent solution, about 100° Tw.) and lime as a slurry. Chlorine gas is injected by a Wallace and Tiernan chlorinator, 4,000 lb. of chlorine being injected per 24 hours. Chlorine is stored as liquid under pressure in a special part of the building in drums which contain 17 cwt. of chlorine each. There are 16 drums, eight being attached in parallel to each chlorinator which serves the two halves of the plant.

The NaOH and lime are metered to maintain the *p*H at 10.8 to 11. Provision is also made to inject sodium hypochlorite to increase the chlorine dose if required or in case of failure of all or part of the normal chlorine supply. (Chlorine can only be drawn from the storage drums as a certain specified rate, otherwise freezing occurs and the supply pipes choke up.) The chlorine additions oxidize the cyanides to cyanates. Sodium thiosulphate is added to remove the chlorine excess at the end of the treatment, the dosage of sodium thiosulphate being 1 cwt. sack to one tank approx., with extra added if necessary. A slight excess of hypo. marks the end point of the dosage.

It is also possible to inject HCl if required to raise the *p*H (reduce alkalinity) of the treated liquor before discharge to sewer. The *p*H value agreed with Luton Corporation for all discharge is from 6.5 to 8.5. The normal maximum, however, is 8.2, the figure of 8.5. being an " emergency " one.

Each of the settlement tanks holds 75,000 gal. and all are fitted with sludge-raking mechanisms ; the sludge is pumped to the filter press house.

It should be emphasized that all treatments are of the batch type, the adoption of this method being regarded by the company as affording a greater safety factor.

Each side of the cyanide plant has its own pumps (2 off) and a third is provided as a standby for either side of the plant, or can be used to move liquor from one tank to any other. A sample of treated liquor is bled off through a continuous-flow electrode system (one for each side of the plant) for *p*H checking.

Each of the six treatment tanks holds 12,000 gal., and as with the remainder of the effluent plant the cyanide treatment plant is very comprehensively instrumented.

Acid Plant

In the acid plant there are eight treatment tanks below an operating corridor into which a part of each tank protrudes. Of the eight tanks, two are used for soluble-oil treatment as referred to earlier. Each tank holds 25,000 gal. of liquor.

Each opposite pair of tanks is coupled to a centrifugal pump of stainless-steel construction, which draws liquor from the bottom of the tank and delivers back into the top to mix the contents. The treatment chemicals are added from pump-delivery pipe lines running over the tops of the tanks inside the operating corridor. From the corridor the dosing of chemicals, the control of all valves, the operation of the circulating pumps and the check on *p*H can be carried out. As in the cyanide plant, instrumentation is very comprehensive.

Treatment consists of circulating the contents of the tanks and dosing direct into the tanks, first with sodium hypochlorite if traces of cyanide are present (as they sometimes are). This is followed by addition of ferrous sulphate (the amount being variable according to Cr content) to convert the hexavalent metal to the trivalent form. A 50 per cent solution of NaOH is then added to adjust the *p*H and precipitate the metals as hydroxides.

From the cyanide and acid plants the treated liquors are discharged to the settlement tanks *via* pumps housed in the central building. Ten pumps are located here, all of the centrifugal type and fabricated in stainless-steel.

Soluble Oil Treatment

In this section (two tanks) the liquor is circulated as in the acid plant. Concentrated H_2SO_4 is added to reduce the *p*H to 3 and to break the emulsion and free the oil. The contents of the treatment tanks are then pumped through an oil flotation tank to float off the oil and allow the oil-free liquor to pass to the sewer at a controlled rate, determined by the *p*H of the liquor from the other plants.

Filter-press House

This contains two 60-chamber S.H. Johnson filter presses fed by three Merrill diaphragm pumps (one standby), with a fourth pump for discharging filtrate which goes either to the sewer or back to the acid treatment plant, according to its condition.

The dry cake capacity of each press is 22 cu. ft., and the two presses together are capable of handling 7,000 gal. of wet sludge per eight-hour shift.

Some Additional Features

Kent level gauges are used throughout the plant, and air compressors and receivers are provided for agitation and for operating the remote-controlled Saunders diaphragm valves in the plant. NaOH and hypochlorite are stored in bulk as solutions in tanks, four for NaOH and two for hypochlorite. Ferrous sulphate and lime are supplied to the plant from mixing tanks.

Around the factory in the drainage system there are a number of oil and grit arrestors. These consist of special rectangular channels for reducing the velocity of the liquors flowing through the drains, so allowing the grit to settle. These channels are regularly sludged out.

FIRE PRECAUTIONS

In block AC fire hazards are a problem, and because of this comprehensive precautions have been taken to minimize them. One of the decisions effecting the design of the building was that of constructing special buildings to house bulk quantities of inflammable materials. These separate buildings are : the paint-mix and paint-stove building ; the boiler house, which serves the main building with high-pressure hot water and steam, and as the boilers are oil-fired, required special fuel-oil tank storage areas ; and the oxygen and compressed-gas storage building.

The nature of the operations taking place within the main building also affected fire-precaution methods, particularly as many of the conveyors pass through openings from one floor to another and through interior walls ; these openings constitute a hazard in so far as they induce air currents and in an unprotected state would allow fire to spread.

The building shell is partly of reinforced concrete and partly steel-framed. Exterior walls are brick, with large areas of asbestos cladding, the window frames are steel, and main roof covering is of incombustible materials. Cavity-deck asbestos is used on flat sections of the roof, and the whole of the remainder of the roof covering is underdrawn with asbestos panelling. Fire walls having a minimum of four-hour fire rating have been erected to separate the various manufacturing areas within the building.

In order to restrict the lateral travel of heat and smoke, and to ensure early and local actuation of sprinkler heads, specially-designed incombustible draught curtains are installed to further segregate the manufacturing and storage areas.

Openings in the walls are covered by double metal-clad fire-doors, which are automatically self-closing in the event of fire. This is achieved by suspending the doors on inclined tracks. The doors are counterweighted to remain in the open position. A fusible element is incorporated in the counter-weighting mechanism, and if the ambient temperature should reach 155° F., the fire-doors will automatically close, thus sealing off the entrance.

In the case of wall openings for conveyors, fire-spread through the openings is countered by means of specially designed tunnels made of incombustible materials. These project on either side of the wall and are protected by automatic sprinkler heads so mounted as to cause a counter-draught to the convected currents which would be induced under fire conditions. Where conveyors are carred from one floor through an opening to another floor, fire-spread is countered by the erection of wedge-shaped hoods, again fitted with automatic sprinklers which direct a finely-divided spray of water to counter the induced convection currents.

One particularly large opening in the trim shop floor, through which completely-trimmed car bodies are lowered on to the final assembly line which runs directly beneath, is protected by a three-sided and topped enclosure constructed of steel-framing and metal-clad asbestos panels. A water-drencher system is housed on the roof of the enclosure. In addition, a water curtain, fed by an alternative water supply, is provided to project water across the underside of the opening.

In the high risk areas, special ventilators, which operate automatically should the ambient temperature reach 155° F., are installed for the release of heat and smoke under fire conditions. They are installed in side-walls and roofs, and the aluminium louvres can be controlled manually as well as by the automatic fusible elements.

Paint Shop

In the paint shop, where spraying is carried out in enclosed spraying booths of the long tunnel type, the booths are equipped with air induction and extraction systems which give frequent air changes within the enclosure to keep explosion possibilities down to a minimum. All booths are of the " wet-back " type whereby cellulose overspray passes through a finely divided screen of water, thus ensuring that no paint residue is discharged to the atmosphere. The paint particles are washed into a water reservoir at the base of the booth. The water is treated with an inhibitor which ensures that the paint particles collected are taken below the surface of the water.

Bulk supplies of paint are not held within this area. Paint is pumped to all points of application through steel piping from the paint mix and distribution building, previously described, located outside the main factory building.

All lighting fixtures and electric motors directly associated with the spraying booths are of the explosion-proof type. In the colour-coat spraying booths there is a pipe line for each of the colours required and each pipe is fitted with a self-sealing coupling which eliminates spillage when colours are being changed.

The distribution pumps for the paint lines, which are located in the paint-mix building, can be remotely cut off from either end of each spray booth. The paint supply lines feeding this shop also have drop-weight valves actuated by fusible elements. All spray booths are fitted with automatic sprinkler systems which have control heads operating at 155° F. These controls feed distribution heads which discharge water at high pressure in a finely divided state.

Dipping Operations

In addition to paint applied by spraying methods —both mechanically and by hand—Vauxhall car

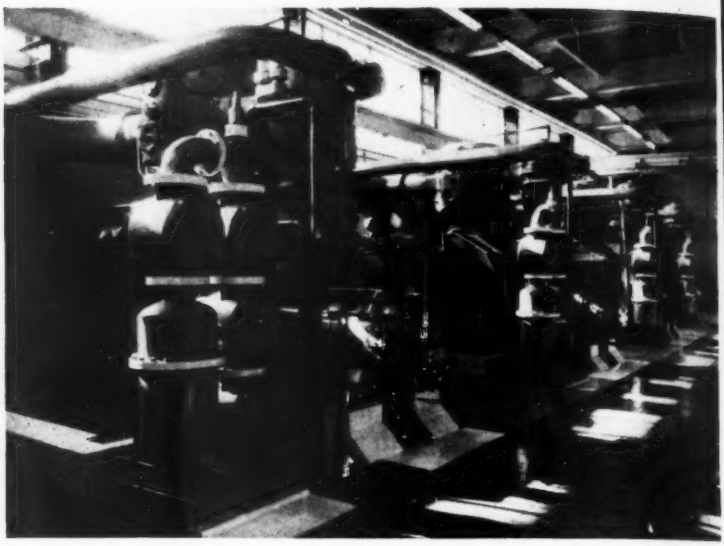


Fig. 34. — Atlas-Copco, compressors in the compressor house.

bodies are partially dipped as complete units into large open-top tanks. The same process is used to treat doors, wings, etc., which are assembled to the vehicle at a later stage. The dip tanks hold up to 3,000 gal. of a special rust-proofing compound which is subsequently stoved on at high temperature. Bodies are conveyed through the system by overhead chain conveyors to the tanks which are enclosed so as to limit and control, as far as possible, the escape of volatiles into the open shop. These sheet steel constructions are equipped with fume-extraction plant to ensure complete and frequent air changes. After dipping, body shells are conveyed to an enclosed flash-off area which incorporates drip trays. Protection against fire in this area is by carbon-dioxide gas, each CO_2 battery operating on a primary and secondary shot system.

A fire-detection system operating on the " rate-of-rise " principle causes the primary CO_2 battery (18 cylinders each holding 80 lb. liquid CO_2) automatically to be discharged in the risk area. The same capacity is immediately available as a manually-operated reserve in the case of a flash-back or prolonged fire conditions.

Special consideration has been given to the need for dumping the contents of the tip tanks at high speed should fire occur. To achieve this a dump tank built in a separate enclosure is located outside the building. In the case of fire the CO_2 gas-operated dump valve automatically opens and discharges the contents of the dip tank.

As a further precaution in this area of special risk, a manually-operated pre-mix foam system is installed, capable of depositing a foam blanket 6-in. thick throughout the area.

Automatic Sprinkler Protection Systems and Water Storage

The automatic sprinklers are installed to the prescribed standards of the National Board of Fire Underwriters of America. Spray-type sprinkler heads are used throughout for ceiling protection, the protection area per sprinkler ranging from 9 sq. ft. to 120 sq. ft. of ceiling area, according to occupancy. The whole building is fully protected by automatic sprinklers comprising 30 separate sets of wet valves. These are fed by a 10-in. dia. ring main, which in turn is fed by two separate sources. The primary water supply is taken from a high-level storage tank with a maximum capacity of 1,600,000 gal., 300,000 gal. of which are reserved solely for the sprinkler supply, and cannot be tapped for any other purpose. The ring-main supply is separated from all other water supply systems.

An excellent gravity pressure is accorded by the high-level storage tank, but the initial pressure and supply is taken from an air-water sprinkler pressure tank of 6,666-gal. capacity.

To supplement this pressure tank, a water-pressure-controlled electrically-operated booster pump with a capacity of 1,000 gal. per min. at 230-ft. head is incorporated in the system. This is further supplemented by a second booster pump of the same capacity, but driven by an automatically-operated diesel engine.

A secondary water system is available from an elevated water storage tank of 300,000-gal. capacity, 100,000 gal. of which are reserved solely for automatic sprinkler supply. The whole sprinkler system in the building consists of approximately 18,000 sprinkler heads.

COMPONENT TREATMENT

Another interesting new installation in the works is a Silvamatic automatic machine built by Silvercrown Ltd., which although primarily designed for automatic plating processes is in this instance utilized to clean, phosphate and oil numerous internal engine components.

This machine is situated within the main engine machine and assembly shop, where all essential parts are fed to the machine. These parts vary from small gears, weighing a few ounces each, to hypoid bevel wheels and pinions in sets with a weight of up to 22 lbs. per set. These are processed at the rate of approximately 4,800 lb per 8 hour shift. These parts after processing are then passed directly to the engine assembly line *via* inspection bays.

The essential dimensions of the " Silvamatic " plant are as follows :—

Overall length.. 20 ft.—10 in.
Overall width .. 9 ft.—0 in.
Overall height.. 11 ft.—6 in.

The machine is based on the standard " Silvamatic " design, which is of the return type double 'U' construction with the Silvercrown transfer mechanism. This is simple in operation and maintenance, the movements being carried out by electro-mechanical means. All controls for the machine are housed in the control console, which can be clearly seen in Fig. 35.

The operating mechanism is located within the main steel structure, around which the various process tanks are arranged. The lift, traverse and lower motions are carried out by mechanical means, which are electronically interlocked to ensure proper timing of each of the various processes. The entire plant is controlled by one operator who loads the work on to the fixtures attached to the carrier arms and unloads the work into suitable containers.

The process sequence is as follows :—

	Process	Immersion Period	Tank Construction
1	Load	4 minutes 40 seconds	—
2	Hot Cleaner	9 minutes 50 seconds	Mild Steel
3	Dragout	4 minutes 40 seconds	Mild
4	Cold Swill	4 minutes 40 seconds	Mild Steel Galvanized
5	Hot Swill	4 minutes 40 seconds	Mild Steel Galvanized
6	Parco-Lubrite	20 minutes 10 seconds	Stainless Steel
7	Dragout	4 minutes 40 seconds	Mild Steel
8	Cold Swill	4 minutes 40 seconds	Mild Steel Galvanized
9	Hot Swill	4 minutes 40 seconds	Mild Steel Galvanized
10	Oil Spray	4 minutes 40 seconds	Mild Steel
11	Oil Drain	4 minutes 40 seconds	Mild Steel
12	Unload	4 minutes 40 seconds	—

The plan layout of the machine (Fig. 36) shows the compactness of the unit.

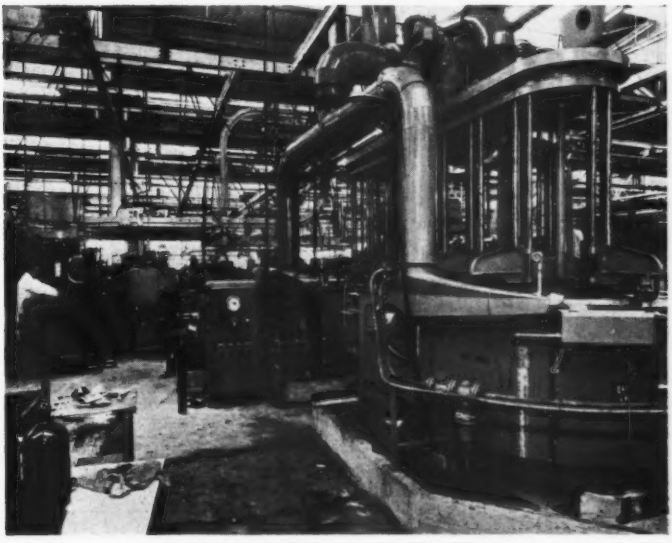


Fig. 35.—View of the Silvamatic automatic machine used before cleaning, phosphating and oiling of certain internal engine components.

The Conveyor Mechanism

The conveyor mechanism consists of two heavy duty chains, one at a level just below the tank top, and the other at a high level, the lower chain being fitted with support rollers which run on a suitable track. At each end of the machine, there is a chain sprocket for each chain, each pair of sprockets being carried on a heavy vertical shaft, one shaft being connected *via* a flexible coupling to a reduction gear box and thence to an electric motor which has incorporated an electro-magnetic brake, the other being an idler. This arrangement accommodates the rotary movement. Interposed between those two chains, on fixed centres around the entire chain, are vertical guides on which the carrier frames are located, these frames being free to slide up and down the vertical guides. It is to these carrier frames that the carrier arm is attached as a firm fixture, it therefore being impossible for a carrier arm to be out of position. Within the double 'U' formed by the chains, is situated a counter balanced lift beam which is operated by a series of roller chains over sprockets and again via reduction gear boxes and one electric motor which incorporates an electro-magnetic brake. It is to the lift beam that the transfer mechanisms are attached at required positions. The operation of the machine is as follows :—

The lift motor "Raises" the lift beam on receiving an impulse from the electronic control unit, and raises all the carrier arms requiring transfer from one process to another, but leaving those requiring longer process at low level. When the lift beam reaches the required transfer height, a cam fixed to the beam operates a limit switch, which passes an impulse to the electronic control unit, which in turn stops the lift motor and impulses the rotary movement motor. The rotary motor moves all the carrier arms forward a full stage, when a further limit switch is operated which again impulses the lift motor to "Lower" the lift beam into its low position. When the lift beam reaches the low position the cam operates another limit switch which stops the lift motor and brings into operation the process period timer, which, in this instance, is a variable electronic timer adjustable between zero and 10 minutes, though set at 4 minutes 40 seconds. After the expiration of the set period, the cycle automatically recommences and will continue to do so until the operator "Stops" the plant.

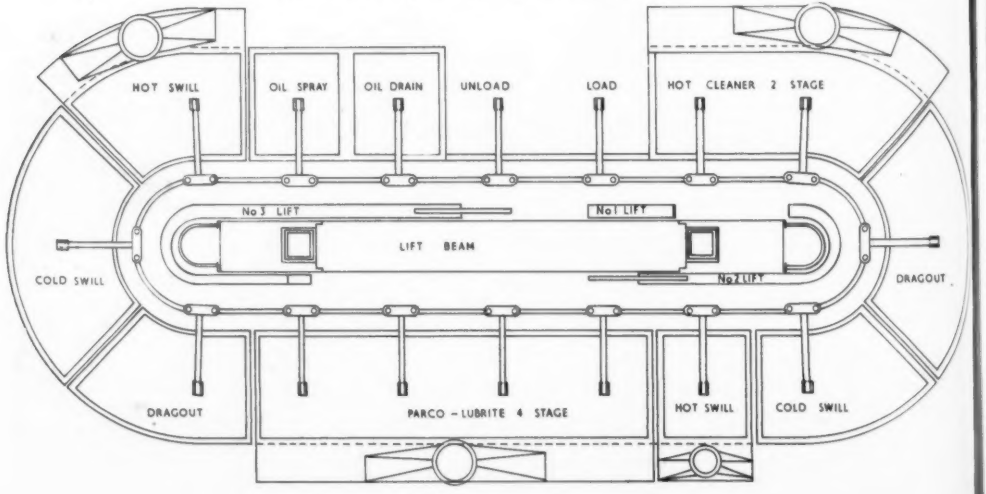
All movements of the plant are fully safeguarded by over-run limit switches, which are so positioned as to prevent any damage to the operating mechanisms should a failure of one of the operative limit switches occur. A further important feature, is the type of electro-magnetic brake employed, which will stop the motors in the event of a power failure. In the event of an over-run, a light on the control console will indicate the movement which has over-run.

Heating.

The various process tanks operating at elevated temperatures are heated by internal high pressure hot water coils, immersed in the solution, each coil having its own thermostatic control valve, together with a flow and return stop valve, there is also fitted to each coil a bleed cock to enable all air to be bled from the system.

(*Continued in page* 244)

Fig. 36.—Diagram in plan of the layout of the Silvamatic phosphating plant.



Production Exhibition

The Third Production Exhibition was held in the Grand Hall, Olympia, last month under the presidency of the Earl of Halsbury. Officially opening the exhibition, Lord Mills, Minister of Power, said that the exhibition showed how we could increase national productivity by using new techniques coupled with less human effort and lower cost. Theme of the conference held at the same time was "Production fights Inflation."

Almco-Supersheen (Divn. of G.B.) Ltd.

Bury Mead Works, Hitchin, Herts.

TWO of the firm's standard barrel finishing units, the DBO.1A and the DB.50, in full working condition as in production, were installed on this stand. Factory conditions were simulated, and these included a gully for the collection and disposal of the process effluent, although effluent disposal was necessary only on the larger DB.50 machine, the DBO.1A having its own sump in the base of the machine so that effluent could be directed to the nearest normal drain through a 2-in. dia. pipe.

The full sequence of barrel finishing procedure could be observed from the loading of media and components, charging with water and compound, and the unloading after the time cycle had been completed. Time indicators informed observers how long each stage would take so that they could return to the stand at intervals to see any particular aspect of the work, if they wished.

On this stand, visitors were invited to take along sample components for processing. Where possible, this was done on the equipment being demonstrated, but if a specialized procedure was required, the part was sent to the firm's main laboratory, processed, and then returned with a report detailing the work undertaken.

Brief details of the units are : DBO.1A. Two separate rubber-lined barrels on a common shaft, each 16-in. across flats by 8-in. wide, with a capacity of 1 cu. ft. each. The barrel door is made of cast aluminium, and is secured by a single-action cam locking device. There is a variable speed drive between 5 and 40 r.p.m. Length is 36-in. and width 32-in. Specification for the larger machine is similar except that the barrel, 22-in. across flats and 24-in. wide, is divided into two compartments, and has a total capacity of 5.6 cu. ft. The drive can be varied between 5 and 30 r.p.m.

Fig. 1.—The DB.O1A and DB.50 barrelling machines (Almco-Supersheen)

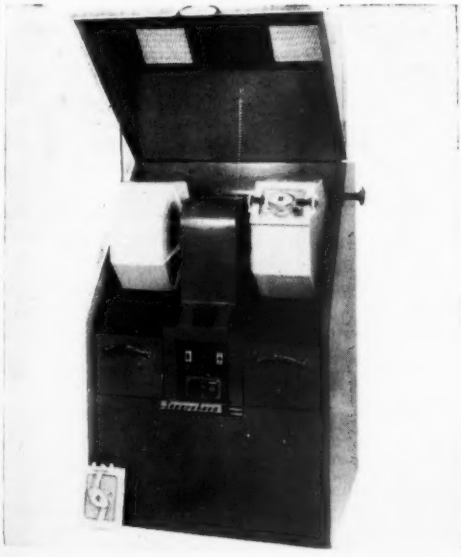


Fig. 2.—A general view of the semi-automatic assembly line (Joseph Lucas). Units produced on the line were sent direct to customers' factories.

Joseph Lucas Ltd.

Great King Street, Birmingham, 19.

THE theme of the exhibition—" Production fights Inflation "—was well exemplified on the Lucas stand where the working exhibit, in the fullest sense of the word, was part of a production and assembly line for fuse boxes. The completed units were despatched from the exhibition direct to car manufacturers.

The line provided an example of the integration of manual and mechanised assembly operations applied to the production of car fuse holders, a unit comprising a bakelite moulding supporting five mutually insulated terminals, two pairs of which are linked by fuses, and spare fuses secured by a riveted spring clip.

Manufacture of two of the component parts prior to assembly was shown, the bakelite mouldings being produced from six impression tools on a Lancastrian automatic moulding press, and the terminals being made on a single spindle auto from special section rod. The pressed components were produced on multi-stage tools and the terminal screws were cold-headed and rolled on a mechanically-fed thread rolling machine.

Shell Chemical Co.

170 Piccadilly, London, W.1.

EXHIBITED on this stand was the range of " Epikote " resins and curing agents manufactured by the company.

The theme of the stand was the way in which plastics materials can be used as an alternative to steel in many tooling applications in the engineering industry.

The range and capabilities of engineering tools made from " Epikote " resins was illustrated by examples drawn from many sources. The exhibits showed how overall production costs can be reduced considerably by using these resins to make such tools as drilling jigs, checking fixtures, vacuum forming moulds, press tools and foundry patterns. Their application was also shown in the manufacture of " plastic metal " stopping compounds for use in general body work, and filling of casting blow holes, for example, in foundry work.

C. C. Wakefield and Co. Ltd.

46 Grosvenor Street, London, W.1.

THE theme of this stand was that Wakefield-Dick production oils, lubricants and lubricating equipment can be used in every stage of industrial production ; from winning the raw material from the earth, to the efficient lubrication of the finished product.

The stand comprised three sections. The first of these dealt with nuclear power and highlighted the part the company is playing in the development of this new and vital service to industry. The second section dealt with oils for production engineering, and showed typical examples of work machined with the aid of Wakefield-Dick production oils. A photographic display illustrating these oils in actual service was also featured. The final section was concerned with mechanical aids to the efficient application of lubricants and production oils. Equipment shown included mechanical oil and grease lubricators automatically feeding controlled amounts of lubricant to any given number of points on a machine.

" Ayrlyne " lubricators and transportable oil dispensers were also displayed. A newly introduced item was the soluble oil mist sprayer delivering a fine mist of coolant in a stream of compressed air, a technique that shows great advantages, in certain circumstances, over more conventional means of application.

Radiant-Heating Ltd.

Radiant Works, Barnsbury Park, London, N.1.

THIS company displayed a number of radiant gas burners, already in use throughout the country on a variety of industrial heating processes, such as galvanising, wire tinning, colour glass firing, mould drying, etc.

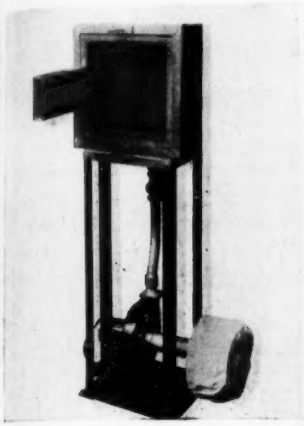


Fig. 3.—A "spread of flame" test cabinet (Radiant-Heating), and (right) the Gas Council's stand, showing the "Jetotubes" installation at the Steel Co. of Wales.

A "preliminary spread of flame" test unit was also shown. This unit enables manufacturers of paints, for example, to carry out their own preliminary tests, complying with British Standard Specification BS 476, Part I, 1953. Specimens under test were placed in a holder and brought into contact with heat radiation from a No. 1 type flameless radiant burner, set at about 875° C. On exposure to heat radiation a 2-in. long vertical luminous gas flame issued from a 1/16-in. orifice to the leading edge of the specimen. Observations were then made of the time of spread of the flame front for measured distances along the longitudinal centre line of the specimen. These units are becoming increasingly popular.

A pre-mix gas and air "incorporator" was used to demonstrate the advantages of mixing gas and air at a central point and feeding it to gas burners on melting and holding pots, etc. A variety of overhead heaters were on show, designed for industrial and commercial users, together with "Duoflam" burners, used for the conversion of solid-fuel fired hot-water and steam boilers.

The Gas Council

1 Grosvenor Place London, S.W.1.

GAS has been harnessed for four thousand different processes in more than a thousand industries, and the background to this achievement was depicted on the Gas Council's stand.

In word, model and picture, the stand showed how the flow of gas is maintained to boost output to industry, and what the gas industry is doing to make sure that tomorrow, and the day after tomorrow, the supply will be there in even greater, and perhaps cheaper, quantities.

Grouped around the exhibit were the stands of six firms who make gas-fired equipment for the workshops of Britain.

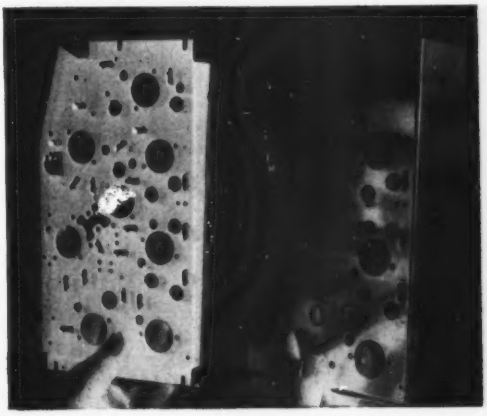
Tin Research Institute

Fraser Road, Greenford, Mddx.

A WORKING electroplating bath was featured on the Institute's stand to draw attention to the latest discovery of a practical method for the electrodeposition of bright instead of matte tin coatings.

The secret of the new bright tin plating process lies in the addition of a specially prepared dispersion of wood tar to the already well-known stannous sulphate bath that has given proven service for many years in the production of matte deposits. The advantages of the new bright tin deposit are that it is not prone to staining in washing or when

Fig. 4.—The radio chassis on the right has a bright tin coating (Tin Research).



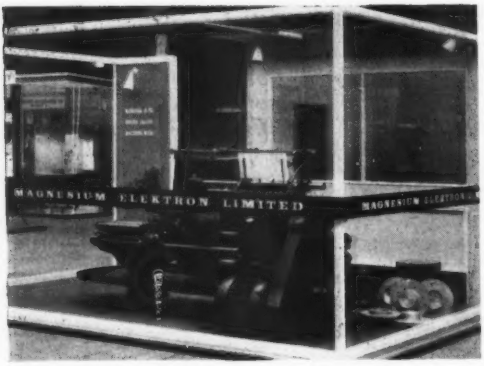


Fig. 5.—This Ward combination turret lathe was used to give demonstrations of the machineability of magnesium (Magnesium Elektron).

handled and that it retains its attractive, shiny appearance indefinitely. Solderability, both when freshly deposited and after storage, is good.

On the stand, radio chassis, loudspeaker frames, and nuts and bolts were being plated to show the simplicity of the " one-bath " process.

As a matter of interest, there are no patent restrictions on the process and full working instructions are available free of charge from the Institute, who are also prepared to advise whenever requested to do so.

The bath composition in grams per litre or lb./100 Imperial gallons comprised stannous sulphate (B.S. 1468) 100 (55 Tin) ; sulphuric acid (S.G., 1.84) 140 ; addition agent 80. The agent contained in addition to the wood tar, sodium n-octyl sulphate as a dispersing agent. The stannous sulphate solution had been filtered through calico *before* the addition agent was added.

A tank of rubber-lined steel, suitable to contain acid tin electrolyte, was used. Heating was not required.

Cathode agitation was used. (With a newly prepared bath, a fairly brisk movement is required but after a period of use, agitation sufficient to prevent gas-streaking is adequate). The current density range for bright plating depends on the speed of the cathode movement and the age of the bath. A Hull Cell test plate, with a still solution, should show a bright deposit for the current density range 15-30 a.s.f.

After plating, the plated work was cleaned by cathodic treatment in an alkaline cleaning solution. The cleaning ensured full brightness and will prevent yellowing in storage. A treatment lasting 10 sec. at 6 volts in 3 per cent trisodium phosphate at 80° C. was used.

The anodes were rolled or cast from standard tin. (99.75 per cent.) They should be of a size suitable for the work and the anode hooks must be kept above the level of the solution.

It has been found that the freshly made bath does not give the best results until it has been worked for some time equivalent to 5 amp hours for each gallon of solution in the tank. The bath composition should not be modified unless bright plating cannot be obtained at any current density. In that event adjustments to the addition agent should be made. The current density range for bright plating may become lower as the bath is worked in.

The revivifying agent is a dispersion enriched in tar relative to the dispersing agent. After a period of use, a decline in the brightness of the plate will occur and fresh addition agent must be added. Control of this addition should be based on plating tests. The Hull Cell is a useful guide, but should not be relied on completely as better results are sometimes obtained in the bath than are indicated by the Hull Cell.

During idle periods there is some loss of brightening activity which may ultimately become complete. A bath which has ceased to give bright plates as a result of standing unused, should be heavily worked with a blank cathode before adding the revivifying solution.

If brittle deposits are obtained, this probably results from an excess of tarry material, suspended in small globules in the solution. These must be removed by filtration under gravity. Filtration under pressure is liable to force the semi-liquid tar through the filter or to clog the press. If, after filtration, the bath continues to give brittle deposits, the addition of a small amount of the dispersing agent will provide a remedy : the amount added should be controlled by plating tests.

Magnesium Elektron Ltd.

5 Charles II Street, London, S.W.1.

A WORKING demonstration on this stand consisted of a Ward Standard No. 7 combination turret lathe on which was demonstrated the ease and speed with which magnesium can be machined.

The operation was carried out on textile warp beam flanges and included the drilling of a large hole, approximately 2-in. in dia. with rough boring to 2⅝-in. dia., and rough machining of the face and boss, together with certain finishing operations. The cutting tools used included both high speed steel and carbide tipped tools.

Also on display were some specimens of magnesium alloy tooling plate, an ideal material for tooling purposes because of its lightness and its weldability. It can be used for bases for jigs and fixtures, for profile templates, welding fixtures, routine templates, stretch forming tools, rubber press form tools, profile plates for " Hydrotel," portable drill fixtures, and locating fixtures, etc.

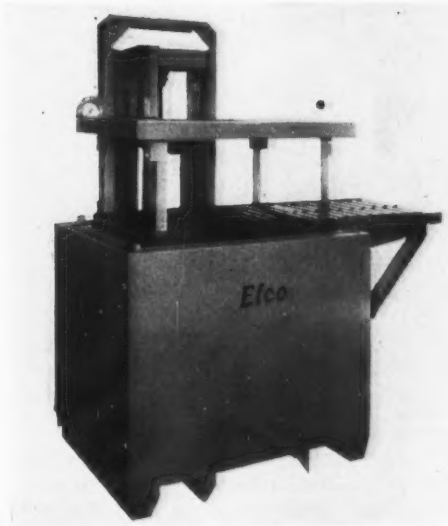


Fig. 6.—(Left) The Efco-Hendor filter unit, and (above) metal cleaning equipment.

Electro-Chemical Engineering Co. Ltd.

Shearwater, Woking, Surrey.,

THE main exhibit on this company's stand was a two-stage spray washer for car engine components.

The spray washer incorporated a full length belt type filter in the wash section capable of filtering 150 gal. per min. of cleaning solution down to a particle size of 5 microns. The filter was not of the by-pass type but received the full flow of cleaning solution as it returned from the spray system to the tank. In addition to offering higher standards of cleaning, this arrangement also eliminated blocked nozzles and the necessity for manually de-sludging the tank.

Other features of the machine include totally submerged vertical pumps, completely eliminating gland leakage and exposed pipework ; automatic solution-level control full-length overflow weirs in both tanks ; individually rated, stainless steel spray nozzles, easily accessible through roller mounted, horizontal sliding doors ; and thermal insulation of tanks and canopies by one inch mineral wool lagging protected by sheet steel cladding.

An Agidip Mk. III, another example of modern metal cleaning equipment, was shown on the stand. Although designed primarily as a washing machine, it is equally suitable for oil quenching and similar operations, and can be used as a single general purpose unit, or in a battery of two or more machines to provide multi-stage sequences. An automatic transfer mechanism is available for this purpose.

A working demonstration of " Zero-Mist " was given. This is an additive for chromium plating baths which completely suppresses the normal mist and spray associated with chromium plating, and factory regulations have been amended so that mechanical exhaust systems are no longer required when the additive is used.

A new high-output filter, the Efco-Hendor filter, was also demonstrated. Constructed entirely from " Perspex " and other materials not affected by electro-plating solutions, it is mobile and designed to take up the minimum of floor space.

A typical Efco-Udylite fully immersed barrel plating unit, suitable for plating small components in a wide variety of electro-plating processes, was displayed.

Of particular interest to automobile manufacturers and associated industries were comparative samples plated in Efco-Udylite bright nickel and subsequently plated to a greater thickness than is customary in a modified chromium plating process. The specimens showed an increased resistance to corrosion and the use of this process could do much to improve plated products in this respect.

S. Smith & Sons (England) Ltd.

Industrial Products Dept., Witney, Oxon. and Jackall Works, Edgware Road, London, N.W.2.

ON display were pumps that can be provided with 3, 5 or 10 radial pistons, spring returned and reciprocated by an eccentric shaft through a contact bearing ring. The pistons work in indi-

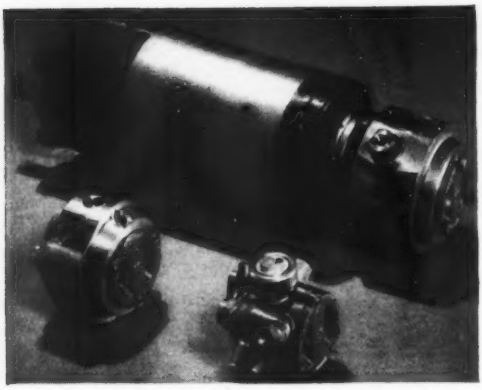


Fig. 7.—High-speed radial plunger pump (Smiths Industrial Products Department).

vidual liners housed in an aluminium body serving as the fluid distributor. The fluid enters the compression chamber through a port and is expelled through a disc valve.

There are various types of these pumps available, giving fluid outputs of up to 5 gal. per min. They can be coupled to A.C. or D.C. electric motors and will operate at up to 2,000 lb. per sq. in. pressure. Other features are that the fluid delivery can be split to operate independent services and that the suction and delivery ports can be arranged to suit the customer. Normally supplied with built-in relief and non-return valves, these can be omitted if necessary. The direction of rotation of the driving shaft does not affect delivery.

Hand operated pumps, designed to cater for the many applications where varying loads have to be moved rapidly within the physical limitations of the operator, are all double-acting.

Various types are available, three and single-speed units, complete with oil reservoir of either ½ or 1 gal. capacity. A screw-down release valve is provided giving fine control and an internal relief valve can be fitted if required.

Capable of working pressures up to 1,750 lb. per sq. in. and giving deliveries of from 0.65 to 1.88 cu. in. of fluid per double stroke, the units are robust, simple to operate and reliable in use.

Also shown were manual lever and auto control valves made by Smiths Jacking Systems Ltd., Jackall Works, Edgware Road, London, N.W.2. The manual valves in some cases incorporate a built-in micro-switch for starting pumps, etc. Twin lever models of these valves are available, designed for controlling two independent hydraulic circuits to be used in conjunction with a split flow "P" series pump.

Capable of working fluid pressures up to 2,000 lb. per sq. in. flow capacities of up to 5 gal. per min. are available depending on the type of valve required.

These manually operated valves can be of blocked centre design or have a free pump flow characteristic with the valve in its neutral position. Other features are lock valves fitted into the jack lines ensuring positive lead holding and the separation of returning fluid from pump circulation, obviating interference from circulating pump pressure. High tensile and hardened steel working component parts are used with light alloy castings for the bodies of these units.

Among the auto control valves on display were line and adjustable relief valves, flow control, flow regulator, flow dividing valves and unloading valves. A sturdy shockproof pressure gauge was also shown. Calibrated 500-3,000 lb. per sq. in., it is unaffected by vibration.

Shown, too, was a range of electro-hydraulic solenoid valves, with coils suitable for D.C. battery operation or A.C. and D.C. mains operation.

Manufactured especially for industrial use, another interesting piece of equipment was the Smiths magnetic particle coupling, an electro-magnetic form of drive coupling having the resilience of its fluid fly-wheel counterpart with the stability of a solid drive device. It has no moving engaging components and while it is a constant torque unit, the torque being independent of speed, it has a safety feature permitting a certain amount of slip when necessary.

Aeraspray Associated Ltd.

179-213 *Thimble Mill Lane, Birmingham, 7.*

A COMPREHENSIVE range of spray painting equipment, including portable and stationary air compressing sets and a typical 6-ft. wide water-washed spray booth of the bench type were displayed here.

The range comprised spray guns, pressure feed containers, air rectifiers and accessories. A newly introduced gun, the type G.12, designed for high speed working with good atomisation, and some automatic spray guns and sensitive fluid pressure regulators for use with the Ransburg electrostatic spray painting process, could also be seen.

There was also a selection of pressure-feed paint containers taken from a wide range of available sizes, with both hand and air-motor driven agitators. Internal air passages have made possible a clean crevice-free head to the containers.

Three air rectifiers, types RP.13, RR.13 and RR.32 were displayed and a feature of these are the removable all-metal filter elements housed in a finned body for efficient air cooling. Clever design with the internal passages and the high-capacity regulating valves gives a very small pressure drop in use. Appearance of the regulators has also been enhanced by the use of a single dial

incorporating both high and low pressure gauges.

A new spray painting traversing unit incorporating a simplified type of chain was shown. Operating parts have been kept to a minimum so that maintenance is also reduced. The firm says that this unit is proving very successful for painting large flat surfaces.

Also shown was the new " Duplex " equipment for the application of polyester resins, incorporating a double-headed spray gun with a dual feed container. A unit for use in the laboratory to handle small quantities at a time has also been developed.

The " Bulldog " portable air compressor and the G.13 intermix spray gun developed for use by the smaller user was shown. The unit is small enough to be carried about and yet is capable of applying a wide variety of finishing materials. The specification includes a $\frac{3}{4}$-h.p. electric motor controlled by a pushbutton starter.

The water-washed spray booth shown had a vitreous enamelled screen, and had the company's well-known washing chamber unit with unchokable water nozzles.

Parkinson Cowan Industrial Products

*Cottage Lane, City Road, London, E.C.*1.

ANOTHER working exhibit was featured on the stand of this company. Metal articles were spray painted with various types of spray gun by hand in the very latest type of waterwash spray booth and afterwards stoved with a 9-ft. Parkinson gas infra-red oven fitted with mag-servo valves, temperature control and indicator, to give a high-quality finish. The articles were, in fact, part of the company's regular production.

Fig. 8.—Spray painting installation (Parkinson Cowan).

There were two items of technical interest. The first was that the oven was sited on top of the spray booth to economise floor space, something commonly done in actual installations for the same reason, and, second, the discharge from the spray booth was emitted onto a very large " Gas Council " sign suspended from the next stand and, although two heavy paints were being sprayed (red oxide and hammer bronze), there was no sign of any pollution on the sign's yellow material.

The conveyor, displayed by courtesy of Teleflex, was some 50-ft. long and was of the dual-directional type. The paint-spraying equipment, (commonly fitted in Parkinson Cowan's installations) was supplied by courtesy of Aerograph DeVilbis. The whole exhibit formed a typical example of a factory installation.

Radio Heaters Ltd.

Eastheath Avenue, Wokingham, Berks.

A PRESS of the W/2P type fitted with the large sliding loading frame arrangement was shown at the exhibition welding padded upholstery panels to the surface of P.V.C./metal laminate sheeting. Assemblies of this type may shortly have wide use in the upholstery and automotive industries.

The " Radyne W/2P " is a high-frequency plastic sheet welding press of novel construction. Of open-span type, the work material can be passed right through the press from front-to-back if required. The daylight between the press pillars is 42 in., which means that material up to a full 36 in. wide can be passed through. Electrodes up to 36 in. wide can be accommodated, and the standard press bolster measures 36 in. x 26 in. The press is pneumatically operated and can be fitted with Radyne generators of 6 kW or 10 kW R.F. output.

Conveyor-type sliding loading frames can be supplied to accommodate pre-cut P.V.C. patterns up to 36 in. x 78 in. or more in length. Large welding electrodes can be mounted in the loading frame, thereby permitting such articles as full-sized inflatable mattresses to be welded by a series of consecutive welds as the trolley is pushed through the press against adjustable automatic register locks. This permits the welding of large articles without any apparent overlap between consecutive welds, otherwise only possible by the use of much larger and more costly " one-shot " presses. A similar system of sliding loading frames can be employed for a wide range of different types of tooling, for example, multiple-impression tools for welding fancy goods of many types. Presses of this general type will shortly be available

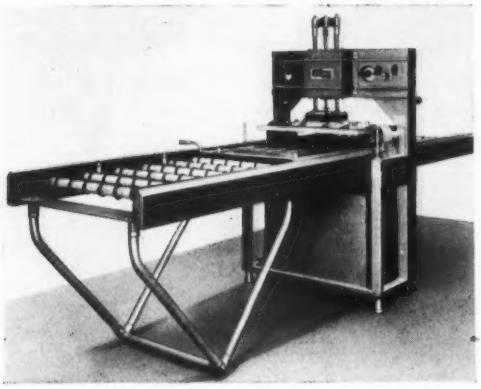


Fig. 9.—A press for welding p.v.c. to sheet metal (Radio Heaters).

capable of passing material 48 in. or even greater in width.

Also on display was a shaft hardening machine with all the facilities required for general purpose production. Other plant demonstrated examples of high-speed induction brazing.

Fletcher Miller Ltd.

Alma Mills, Hyde, Cheshire

IN harmony with the theme of both the exhibition and conference, examples of interesting machining set-ups were featured on this stand. These included production deep-honing to fine micro-finish, an unusual example of multi-stage boring, the milling of titanium alloy, and the broaching of automobile components. Each of these was given in the form of a case history and had the fullest documentation possible so that the visitor could inspect for himself a photographic record of the tool area, specimen components taken from the run, the actual tools used, and details of the Fletcher Miller cutting fluid employed in each of the production gains featured. The display was planned on informational lines so that the exhibits themselves told the whole story of production lubricants at work.

Desoutter Bros. Ltd.

The Hyde, London, N.W.9.

SHOWN for the first time at any exhibition, Desoutter Bros. displayed a new range of "Mighty Atom" and "Power Atom" pneumatic drills with $\frac{3}{16}$-in. to $\frac{1}{4}$-in. capacities, designed to work quieter and easier than anything previously marketed by this company.

New features that could be seen were a chuck guard/silencer that reduced exhaust scream to a low purr, and an improved plastic grip that was unaffected by oil and moisture from the hands. In standard form the tools are fitted with a push button control top but a pistol grip or lever control are available if required.

Grauer and Weil Ltd.

Hardwick Street, London, E.C.1.

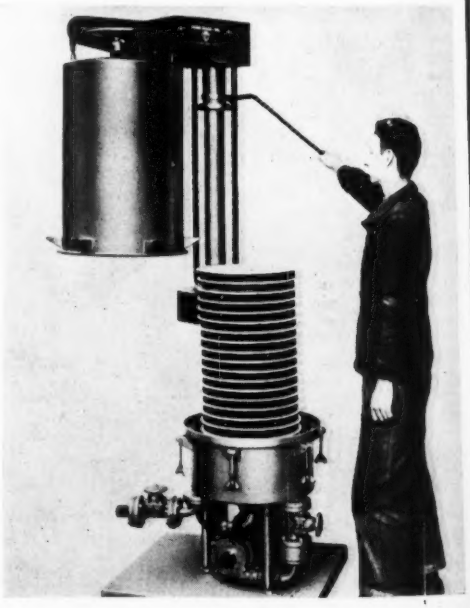
SHOWN on this stand were two new filters for electroplating solutions, filtering out to micron size, having a high filtering capacity and surface area, and requiring a minimum of maintenance.

A new electroplating barrel unit with various sized barrel perforations, and a plating tank equipped with a new range of electrical clamps and spring clip connections for anodes and conductors to give both positive contact and rapid assembly or dismantling were also shown.

Also on view were the company's conventional solid bar polishing compositions, illustrating the wide range of sizes available to suit modern automatic machine applications. There was also a range of new liquid polishing compositions and spray gun equipment, mounted against a variable-speed independent-ended polishing lathe. The company has recently acquired the sole agency in the U.K., Australia and New Zealand for the lathe.

Of interest, too, was a patented "Paraflow" mop that combines vigorous cutting and finishing properties with cool running and can be manufactured to suit the profile of various workpieces.

Fig. 10—Arrangement of the filter pads and separator plates in the Teddy Dever filters (Grauer and Weil).



FINISHING NEWS REVIEW

INDUSTRIAL WELFARE

HOW many foremen know the sound of their own voices as heard by the workers in their charge? Delegates to the thirty-fifth weekend conference for foremen and forewomen, organized by the Industrial Welfare Society and held at the Grand Hotel, Brighton last month, had a chance to find out.

Photo: Mark Gerson, London

Mr. John Marsh

As part of the study of clear speaking on which a barrister, Mr. Brian Power, lectured at the conference, delegates were able to record and playback their own voices.

The foremen's relationship to the nation's economic problems was studied by Mr. J. Campbell Fraser, public relations officer of the Dunlop Rubber Co. Ltd.

Mr. H. J. Hebden, personnel manager of Venesta Ltd. discussed how changes in the nature of industrial discipline affect the foreman, and the education and training officer to the Central Electricity Generating Board, Mr. J. H. Ramsden, examined the effects of work study on the foreman's responsibilities. The role of shop steward was the subject for Mr. John Holland, I.W.S. assistant director; and the impact of modern management upon the foreman was assessed by I.W.S. director, Mr. John Marsh.

Mr. Marsh said that human relations can be defined as the day to day relations between people throughout all levels of any enterprise. On the other hand, industrial relations can be defined as the instrument of bargaining between employers and trade unions on wages and working conditions.

Scope for Development

"The average income per head of the western world's working population is £300 a year while for the world's underdeveloped countries the average income is only £20 per annum. If this disparity is to be alleviated then there is obviously much scope for industrial development everywhere."

Happiness at Work

He went on to say that a real problem of growing size is how to make work itself satisfying in the rapidly developing age of automation, electronic controls, etc. "Men and women must find happiness and success in their local surroundings—at work, in the family, in their streets and towns. To do this we must develop our educational programme towards the growth of the whole man. Much depends on our future use of education."

WHITE RUST FORMATION REDUCED

New process for galvanized sheet

A PROCESS to reduce if not entirely eliminate the formation of white rust on galvanized steel sheets was announced recently by John Summers and Sons Ltd., the Shotton, Chester, steel company.

Very substantial financial losses have been suffered due to the formation of white rust during shipment and storage, and attempts to solve a problem that has existed since the early days of galvanized steel sheet manufacture have been continually made by steel companies throughout the world. This development is a triumph for the enterprise of a British company.

The new process, already being included as part of their manufacturing technique of "Galvatite," a galvanized steel sheet product, has been developed by Summers' own research team and does not diminish the brilliance of the sheet surface nor reduce the spangle.

The formation of white rust appears on galvanized sheets when for example, rain and changes in temperature cause moisture to form on the sheets. The chemicals in the small globules of moisture react, destroying the all-important uniform zinc protective coating on the steel. The new Summers coating process prevents the initial reaction from taking place.

The company has spent a long time testing the process. In one case, sample sheets of Galvatite were sent by sea to New Zealand and back. They encountered considerable changes in temperature and weather but returned to England in perfect condition without any signs of white rust formation, while untreated sheets on the same journey showed appreciable white rust.

FILMS ON MECHANICAL HANDLING

THE National Joint Committee on Materials Handling, a co-ordinating committee for professional and other bodies interested in materials handling, particularly from an educational standpoint, has compiled a list of films on the subject, now available upon receipt of a stamped addressed envelope from The Secretariat of the committee at 20/21, Took's Court, Cursitor Street, London, E.C.4.

Some 60 titles have been listed showing the size and running-time (where known), the source of film and a brief synopsis of its purpose and audience suitability.

The need for and value of better handling methods in British industry is amply demonstrated in many of the visual aids catalogued.

SOCIAL EVENING FOR ENAMELLERS

THE ninth annual social evening of the Southern Section of the Institute of Vitreous Enamellers was held in a private room of Kettner's Restaurant, Soho, London, recently at which 46 members, their ladies, and guests were present. After the loyal toast, a toast to the guests was proposed by the section chairman, Dr. B. K. Niklewski. The response was by the chairman of the Council of the Institute, Mr. J. H. Gray.

After an enjoyable dinner, the entire company adjourned to the Victoria Palace Theatre, for a performance by the Crazy Gang of "These Foolish Kings."

Belle Vue Exhibition

Manchester Fair of Industry and Commerce

A BRITISH fair of industry and commerce, open to the trade and to the general public, is to be held from July 4 to 19 this year at Belle Vue, Manchester.

It is hoped that the event, Belle Vue's first major entry into the exhibition field, will be an annual one. As its name suggests, its initial appeal has been on a very broad basis.

The response, say the promoters, has been heartening.

No claim is made that the British fair is or could be a successor to the B.I.F., but it has been found that it has in some cases filled the gap for those who exhibited there.

SOLE AGENCY FOR INSTRUMENTS

STARTING last month, a new instrument company, Research and Control Instruments Ltd., Instrument House, 207, Kings Cross Road, London, W.C.1 (telephone: Terminus 8444) became the sole distributors in the U.K. for the electronic instruments and scientific equipment hitherto marketed by Philips Electrical Ltd. (Research and Control Instruments Division). Maintenance of existing Philips equipment will be undertaken from a new service department and stores at 49, Temperley Road, Balham, London, S.W.12. (Telephone: Battersea 9166 and 9197). In addition, the company are distributors in the U.K. for the industrial X-ray equipment manufactured by C. H. F. Müller A. G., Hamburg, and for Norelco (U.S.A.) X-ray diffraction and spectrographic equipment. They have also been appointed sole distributors for the sale and servicing of Mullard electronic measuring instruments and electro-chemical apparatus in the U.K., supported by Mullard Equipment Ltd. Also to be handled by Research and Control Instruments Ltd., and new to the British market, will be the electronic instruments made by Elektro-Spezial A.G., of Hamburg.

U.K. LICENSEES TAKEN OVER

THE controlling interest in Modern Patents and Processes Ltd., electrolytic specialists in the electropolishing of metals, has been acquired by Roto-Finish Ltd., Mark Road, Hemel Hempstead, Herts., from Jacquet-Hispano Suiza, S.A.

M.E.P.P. Ltd. was formed in 1948 to develop the industrial applications of electrolytic polishing and chemical brightening. The company was granted an exclusive licence in the U.K. and Commonwealth for the metal finishing processes held by the Battelle Development Corpn., U.S.A., and by the Jacquet-Hispano Suiza group in France. The processes were covered by world patents and M.E.P.P. acquired over 25 British, Australian and S. African patents.

Aero Engine Makers First Licencees

Among M.E.P.P.'s first licensees were Rolls-Royce Ltd., who used the electropolishing processes for the turbine and compressor blades of their jet engines. Others were D. Napier and Son Ltd., Joseph Lucas Ltd., the Ministry of Supply, and the Australian Government. The M. of S. acquired a licence for the processes as applied to aero engines. Close collaboration between the company and the research laboratories of both Rolls-Royce and Napier's resulted in three R-R patents being assigned to M.E.P.P.

German Agency

More recently, M.E.P.P. obtained the exclusive rights for the U.K. and Commonwealth of the processes developed by Elektrolyse Gesellschaft m.b.H. of Munich, specialists in the electropolishing of non-ferrous alloys, and machines and chemicals for carrying out one of these, the "Polygrat" process for polishing brass and copper alloys, have been introduced to the U.K. recently by M.E.P.P.

Battelle Connexion

A founder of M.E.P.P., Dr. H. E. Zentler Gordon who was for more than five years a consultant to Battelle and is still their U.K. representative, remains on the board. Other members of M.E.P.P.'s reconstituted board are Roto-Finish's managing director, Mr. George Meier, and development director, Mr. R. B. Olliver. Pending the completion of a new building at Mark Road, Hemel Hempstead, M.E.P.P. will remain at 56 Bryanston Street, London, W.1. The new accommodation will have an extensive demonstration laboratory.

Roto-Finish and M.E.P.P. will maintain the closest technical liaison and are setting up a joint advisory service for deburring and polishing.

MONORAIL MOVES

HOUSED at Wren Works, Chadderton, Lancashire, since its formation in 1952, British MonoRail Ltd. has moved to a new, modern factory in Wakefield Road, Brighouse, Yorkshire.

Last year a group of industrialists and financiers, led by Mr. James Dallas, chairman and managing director, brought the 80 per cent British shareholding. Business has more than doubled since then and it is expected the present staff of 180 will be increased to 500 in the next three years. Twenty per cent of the company's shares continue to be held by the American MonoRail Co.

The new telephone number is Brighouse 2244 (five lines).

NO BID

THE attention of the board of Venesta Ltd., Vintry House, Queen Street Place, London, E.C.4, has been drawn to continuing reports that a bid is about to be made for the ordinary shares of the company.

They wish to state that no offer or approach of any kind has been made to them, nor have they any reason to expect one.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Improved Barrelling Machine

INCREASED production facilities have lowered the price of the Roto-Finish DW 16/16/2 barrelling machine, and six improved features have recently been incorporated into the design. The improvements are : it is now fitted with a Venner PT.4 repeating process timer : the lever type door locking mechanism has been replaced by a more convenient and efficient centre locking door ; the door incorporates a T-section fabricated gasket of rubber, with a sealing width of $\frac{3}{8}$ in. which enables high sealing pressures to be obtained by finger tightening ; an improved limit switch which cuts out the motor on a small initial movement of the guard ; a reversing switch ; and a variable speed drive.

The machine is marketed by Roto-Finish Ltd., Hemel Hempstead, Herts. (Fig. 1).

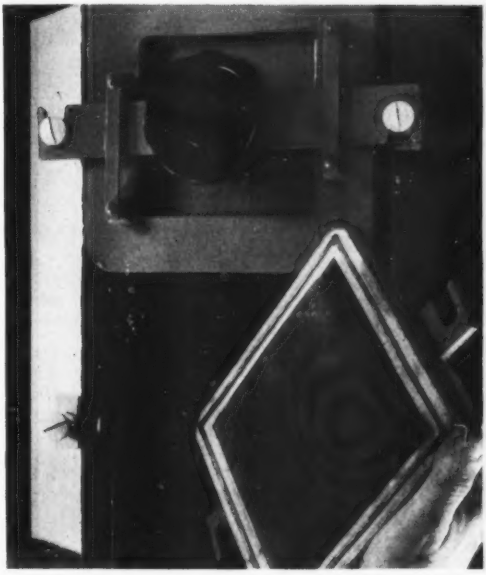


Fig. 1.—Improvements to this barrelling machine include a quick release centre-locking device and a tee-section gasket.

Anti-Rust Primer is Aluminium-Based

A PAINT that combines the advantages of aluminium paints for industrial purposes with good corrosion resistance was announced recently by Paripan Ltd., 1, Sherwood Street, London, W.1. The paints are Parinium primer, and Parinium silver finish, an air-drying, oil-type aluminium showing good results against corrosion on ironwork. Parinium will not take the place of red lead, but it can be included in the range of materials that resist corrosion on steel and ironwork, the makers say. Qualities claimed for the products are : anti-corrosive properties on ironwork ; high head reflection properties ; good adhesion to metal surfaces over traditional aluminium paints ; considerably lower weight per gallon ; non-toxicity ; and a low price.

Parinium primer is a non-leafing aluminium, inclined to be dullish in colour, and best results are obtained by brush application although it can be sprayed.

Parinium silver finish is a leafing aluminium with a bright finish and is more attractive from a decorative point of view, used where a second coat is allowed for. Application can be by brush or spray.

Dip-Plating Process

A NEW gold dip-plating process "Atomex" has been introduced by the Baker Platinum Division of Engelhard Industries Ltd., 52 High Holborn, London, W.C.1. The process requires no current or special equipment as the plating takes place by ionic displacement. Chemically attacked, the base metal surface sheds atoms into the bath which are replaced by atoms of gold from the bath. The major advantage is over electro-deposition claimed for this process are : coating is denser, so that the same appearance is achieved with 35 per cent. less gold ; since there can be no electrical shielding, there are no low or high-density areas—all parts of the object receive a uniform deposit ; analytical bath control is unnecessary because there is no free cyanide or carbonate build-up; all the gold in the bath can be used.

Successful deposits have so far been achieved on a wide range of metals, including copper, iron, steel, cadmium, die-cast alloys, zinc, and nickel.

Atomex has already found wide use in the U.S.A. for the plating of printed circuits, lamp components, metallized plastics, and electrical plug inserts, as well as for the more conventional plating of costume jewellery. Literature on the process is available on request.

Portable Barrel Pumps

AN addition to the range of portable electric barrel pumps manufactured by the British Central Electrical Co. Ltd., 6 and 8 Rosebery. Avenue, London, E.C.1., was announced recently.

The new range has been introduced primarily to handle the more viscous liquids beyond the scope of an earlier model. (Fig. 2).

Among the many features of the new pump is an increase in the maximum motor loading to 400 W., and the addition of a fan to cool the motor casing when the pump is in operation. Other features are :

The lifting and inner tube assembly containing the driving shaft is easily removable and is interchangeable. By replacing the assembly with one made from stainless steel, for example, the pump can also be used for acids or other corrosive liquids.

The lifting tube is reinforced at the lower end, and has an overall diameter of $1\frac{5}{8}$ in. so that it can easily be inserted into normal barrel entries.

The self-priming pump will operate against full pressure, i.e. when in use with the tap closed, it will continue to function without overloading.

Power transmission is through an 0.2-in. driving shaft via a positive coupling. If the pump becomes overloaded or overheated (beyond 60°F) by the liquid being pumped, a thermal overcurrent cut-out in the motor housing disconnects the supply until the pump cools.

The pumps are suitable for a large range of industrial uses where liquid has to be transferred from one container to another. The saving in time over manual methods will quickly save the cost of the machines.

Distributors are : Northern Counties, Caselco Ltd., 46 Park Square, Leeds, 1. Midland Counties, Selwood Engineering and Pump Co., 8a Solihull Lane, Hall Green, Birmingham 28.

Solutions for Simultaneous Plating of Tin and Lead

NEW plating solutions have been developed by Dalic Metachemical Ltd., Toronto, Ont,. Canada, to allow tin and lead to be plated singly, or in combination, in any proportion of value to the user. High lead-content alloys (93 per cent) are suitable for bearing applications ; 60-40 tin-lead alloys are ideal for components requiring subsequent soldering. These and any intermediate percentages for special purposes are readily achieved merely by mixing the solutions in proper volumetric proportions.

Both the new Dalic plating solutions are slightly alkaline, the tin having a pH of about 7.5, the lead ranging between 8.0 and 8.5. They will not set up corrosion cells, will not cause embrittlement, and do not attack different neighbouring metals.

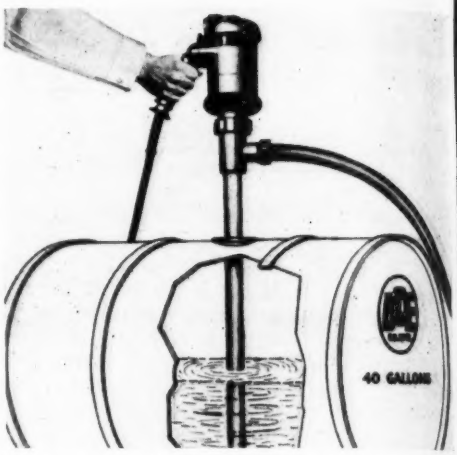


Fig. 2.—A portable electric barrel pump handles viscous liquids beyond the range of an earlier model

The tin and lead electrolytes have been designed specifically for use with the company's selective area plating equipment, in which, the makers say, higher current densities are possible than in conventional plating baths so that, combined with the continuous agitation inherent in the Dalic process, a much denser deposit is achieved. In fact, the deposit of the new alkaline tin is so fine-grained, that it may be burnished to a high gloss with cotton batting alone, without using polishing compound. A better bearing surface, having fewer high spots and voids, is the result. Also, the deposit is harder than the one obtained with the preceding formulation. Rates of deposition are unusally high, as much as 1 mil. thickness per sq. in. per minute.

Using the Dalic process, a special rectifier transforms 220-V a.c. into d.c., a stepless voltage-control permitting the selection of any voltage from 0 to 35. Most plating is carried on at about 8 to 20 V.

Electric current is sent through the part to be plated by a cathode lead, clamped to the part, and the stylus which applies the electrolyte. The stylus includes a high-purity graphite anode, wrapped in cotton and saturated in the plating solution. Any metal may be plated on almost any other, simply by choosing the proper electrolyte. Surfaces up to 2 sq. ft. are normally the limit for this process, because it is intended primarily for smaller areas. However, larger units may be plated in prototype work, or, when usually large, special plating tanks would have to be built to accommodate the part.

Classified Advertisements

Prepaid rates: FIFTEEN WORDS for 7s. 6d. (minimum charge) and 4d. per word thereafter, or 24s. per inch. Box number 2s. 6d., including postage of replies.

SITUATIONS VACANT

METAL FINISHING-ENGINEERING MANAGER required for two factories. Must have a bent for simplicity and efficiency. Dohm Ltd., 167, Victoria St., London, S.W.1.

MACHINERY FOR SALE

NEW SHEET METAL GRINDING AND POLISHING MACHINES by Johannsen, for sale. Motor driven 400/440/3/50. Single and double belt models in four sizes to take all kinds of sheet metal up to 9′ 11″ x 4′ 11″. Full details and illustration from F. J. Edwards Limited, 359, Euston Road, London, N.W.1. Euston 4681, or 41 Water Street, Birmingham 3, Central 7606.

I.C.I. CONVEYOR TYPE DEGREASING PLANT, overall size 20′ x 6′ x 11′ high. Low price to clear. Box 204, METAL FINISHING JOURNAL

I.C.I. DEGREASER, bench model, copper construction, electrically heated, unused. £30. Box 205, METAL FINISHING JOURNAL.

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The Dalic process makes it possible to plate partial areas without excessive masking or stopping-off. The equipment is mobile, and often work can be handled in place, without dismantling and subsequent reassembly. Almost any metal from bismuth to zinc may be deposited, without plating tanks ; only a change of plating stylus and electrolyte is necessary

British representatives of the company are Metachemical Processes Ltd., 41-3 Gatwick Road, Crawley, Sussex.

Masking Tapes

AN all-purpose masking tape that can be used for all masking operations in temperatures up to 150°F. (up to 2 hours' duration), was introduced recently by Industrial Tapes Ltd., Speedfix House, 142/146 Old Street, London, E.C.1.

It can be used to replace all normal varieties of paper masking tape other than specialised high temperature tapes. Main advantage claimed for the tape is its thinness and consequent greater flexibility. Thinness is desirable when there is a likelihood of paint edges being built up against the edges of the masking tape. Flexibility is an advantage as it permits the easier and more accurate masking of curves and contours. (Fig 3).

The high adhesion of the tape provides additional holding power for " apron " applications, i.e. when holding templates in position.

Its very high tensile strength is advantageous when a close seal on awkward or curved surfaces is required. In spite of the high adhesion, the makers say that the new tape unwinds more easily than conventional tapes.

Gloss Enamel That Dries Overnight

ONE of the main difficulties that have beset the paint user and decorator during winter painting is the unreliable drying characteristics of many enamels and oil paints when used in unheated factories or buildings, and on equipment in cold workshops.

Fig. 3.—Masking tapes

Although it is often possible to supply paint during the daytime at normal temperatures, the paint film is frequently subjected to very cold air during the night when the heating is shut off. As a result the paint film may not dry properly and will remain sticky to the touch, sometimes even for days. Furthermore, many oil paints tend to lose their gloss and become subject to unsightly blooming when applied under unfavourable conditions.

To overcome these problems the research laboratory of Allweather Paints Ltd., 36, Great Queen Street, London, W.C.2. has developed a new enamel " Pitalux W " which dries overnight and under cold conditions to a smooth and hard glossy finish. Its durability is good and comparable with any standard type enamel, say the makers.

Although the finish is normally used for interior application during low temperature conditions it can be applied outside provided the area to be painted is sheltered.

Finishing the Vauxhall Car

(*Continued from page* 230)

Fume Extraction.

As the machine is situated in the centre of a machine and assembly shop, the extraction of all fumes and vapours is of great importance. This has been taken care of by two separate extraction fans drawing the fumes from the various processes via lip type exhaust hoods. The fans discharge through trunking to atmosphere.

Control Console.

The control console is situated on the floor adjacent to the load position and contains all the main electrical operating equipment except the motors and limit switches. On the front face of the console is the distant reading thermometer for the Parco-Lubrite process tank ; directly below the thermometer is the adjustable control for the process timer ; to the right of the timer are the indicator lamps, one for each of the two extraction fans and one for the oil spray motor. Below the timer is the indicator lamp for the main operation, and to the left are the over-run indicator lamps, one for rotary over-travel movement, over for main beam over-travel " Up " and one for main beam over-travel " Down ". The four push-button stations in line across the centre are :— one for each Fan, one for the oil spray motor and one for the main plant. Each circuit is fully protected against overload and the master isolating switch is mounted on the side of the console. The two sides and back of the console are in the form of doors to allow easy maintenance of the equipment.

Interlocked emergency stop buttons are situated in strategical positions about the machine, and the machine cannot be restarted until the operator resets at the control console.